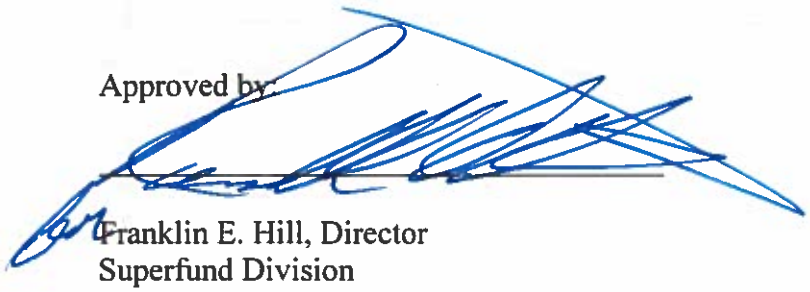
Sixth Five-Year Review Report
for
Celanese Corporation (Shelby Fibers Operations)
NCD003446721

Grover
Cleveland County, North Carolina

August 2016

United States Environmental Protection Agency
Region 4
Atlanta, Georgia

Approved by:



Franklin E. Hill, Director
Superfund Division
EPA Region 4

Date:

8/18/16

Sixth Five-Year Review Report
for
Celanese Corporation (Shelby Fibers Operations)
2525 Blacksburg Road
Grover
Cleveland County, North Carolina

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List of Acronyms

ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CIC	Community Involvement Coordinator
CNA	CNA Holdings, Inc.
COC	Contaminant of Concern
COD	Chemical Oxygen Demand
DNAPL	Dense Non-Aqueous Phase Liquid
EG	Ethylene Glycol
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
FYR	Five-Year Review
GRUB	Glycol Recovery Unit Bottoms
GWRS	Groundwater Recovery System
HI	Hazard Index
IC	Institutional Control
IDR	Independent Design Review
IT	Inner Tier
MCL	Maximum Contaminant Level
mg/L	Milligrams per Liter
MNA	Monitored Natural Attenuation
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
NCDEQ	North Carolina Department of Environmental Quality
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operation and Maintenance
OT	Outer Tier
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCE	Tetrachloroethylene
PRP	Potentially Responsible Party
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
S&ME	Soil & Material Engineers, Inc.
SVOC	Semi-volatile Organic Compound
TBC	To-Be-Considered
TCE	Trichloroethylene
VISL	Vapor Intrusion Screening Level
VOC	Volatile Organic Compound
WWTP	Wastewater Treatment Plant

Executive Summary

The Celanese Corporation (Shelby Fibers Operation) Superfund site (the Site) is located in Grover, six miles south of the City of Shelby, Cleveland County, in southern North Carolina (Figure 1). Since 1960, different companies have manufactured polyester polymer chips and filament yarn at the Site. Facility operations previously included on-site burning and burial of plant wastes, storage of drums containing waste chemicals and solvents, and on-site discharge of chemical wastes. These waste disposal activities contaminated soil, streambed sediment, surface water and groundwater with volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs) and heavy metals.

The U.S. Environmental Protection Agency placed the Site on the Superfund program's National Priorities List (NPL) on June 10, 1986. Celanese Corporation (Celanese) is the Site's potentially responsible party (PRP). In 1995, the PRP connected nearby off-site residences to Cleveland County's municipal water system.

To manage the cleanup, the EPA divided the Site into two operable units (OUs). Cleanup of OU1 addressed contaminated groundwater and included construction and operation of a two-tier groundwater extraction and treatment system. In 2004, the EPA modified the OU1 remedy with an Explanation of Significant Differences (ESD). The ESD changed the OU1 remedy to a two-year trial period for monitored natural attenuation (MNA) and modified the groundwater treatment approach, following the MNA trial period. To address residual groundwater contamination, Celanese installed three extraction wells at the former glycol recovery unit bottom (GRUB) disposal area in late 2012. Currently, MNA and the operation of the GRUB area groundwater recovery system (GWRS) address remaining groundwater contamination at the Site.

Cleanup of OU2 included excavation of contaminated source wastes and soil in the GRUB area and burn pits, as well as impacted sediment in one streambed, followed by treatment with on-site incineration, stabilization and backfilling of the treated media into the excavations, located in the vicinity of the former GRUB area. Celanese led site cleanup activities and completed the construction of the OU1 and OU2 remedial actions in 1993. The EPA deleted OU2 and the outer tier (OT) groundwater extraction and treatment component of the OU1 remedy from the NPL in 1998. The triggering action for this five-year review (FYR) was the signing of the previous FYR on August 31, 2011.

Because the remedies for OU1 and OU2 are protective in the short term, the sitewide remedy is currently protective. For the remedy to be protective over the long term, the following actions are needed: finalize institutional controls to prevent future groundwater use at the site property, to prevent exposure to residual source area soil contamination and prevent activities that could compromise the integrity of the selected remedy in the future, and document the need for institutional controls in a decision document; collect groundwater samples from points outside of the current monitoring well network to adequately determine the full extent of the 1,4-dioxane plume; ensure all detection limits currently used to analyze groundwater COC concentrations are as low as, or lower than, all COC cleanup goals and change analytical methods used to analyze groundwater if needed. In addition, evaluations are needed to determine the cause of the increase in dense non-aqueous phase liquid (DNAPL) in well F-55 and to determine if the GRUB area GWRS and MNA are capable of adequately addressing the sources of trichloroethylene (TCE) in the TD-well area, DNAPL and SVOCs at well F-55, and 1,4-dioxane in sitewide groundwater. Based on evaluation findings, implementation of additional remedial actions may be needed.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Celanese Corporation (Shelby Fibers Operations)		
EPA ID: NCD003446721		
Region: 4	**State:** NC	**City/County:** Grover, Cleveland County

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA **If "Other Federal Agency" selected above, enter Agency name:** Click here to enter text.
Author name: Melissa Oakley (Reviewed by EPA)
Author affiliation: Skeo Solutions
Review period: 11/23/2015 – 8/31/2016
Date of site inspection: 2/17/2016
Type of review: Statutory
Review number: 6
Triggering action date: 8/31/2011
Due date *(five years after triggering action date)*: 8/31/2016

Five-Year Review Summary Form (continued)

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
None

Issues and Recommendations Identified in the Five-Year Review:

OU(s): OU1 and OU2	Issue Category: Institutional Controls			
	Issue: Institutional controls were not called for in site decision documents. Due to the presence of site-related contamination above concentrations that allow for unrestricted use, land and groundwater use restrictions are needed for both the site facility property and downgradient properties. Institutional controls have not been implemented for the site facility property.			
	Recommendation: Finalize institutional controls for the site facility property to prevent future groundwater use. For areas of the site facility property where residual soil contamination remains, finalize institutional controls to prevent exposure to residual source area soil contamination and prevent activities that could compromise the integrity of the selected remedy in the future. Document the need for institutional controls in a decision document.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP and EPA	EPA	08/31/2018

OU(s): OU1	Issue Category: Remedy Performance			
	Issue: Groundwater monitoring data indicate that MNA and the operation of the GRUB area GWRS may not be capable of adequately addressing residual sources of groundwater contamination at the Site. Specifically, current groundwater remedial actions do not seem capable of effectively addressing TCE in the TD-well area, DNAPL and SVOCs at well F-55, and 1,4-dioxane in sitewide groundwater.			
	Recommendation: Perform an evaluation to determine if the GRUB area GWRS and MNA are capable of adequately addressing the sources of TCE in the TD-well area, DNAPL and SVOCs at well F-55, and 1,4-dioxane in sitewide groundwater. Also perform an investigation to determine the cause of the increase in DNAPL in well F-55. Based on evaluation findings, implement additional remedial actions as needed.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	08/31/2018

OU(s): OU1	Issue Category: Monitoring			
	Issue: Between 2011 and 2015, in a few instances, the laboratory detection limits used to analyze groundwater samples for benzene, 1,4-dioxane, ethylene glycol, naphthalene and bis(2-ethylhexyl)phthalate were higher than the established cleanup goals.			
	Recommendation: Review all detection limits currently used to analyze groundwater COC concentrations to ensure that all detection limits are as low as, or lower than, COC cleanup goals. Change analytical methods used to analyze groundwater if needed.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	08/31/2018

OU(s): OU1	Issue Category: Monitoring			
	Issue: The current extent of 1,4-dioxane contamination in site groundwater has not been fully defined.			
	Recommendation: . Collect groundwater samples from points outside of the current monitoring well network to adequately determine the full extent of the 1,4-dioxane plume.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	08/31/2018

Protectiveness Statements

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU1	Short-term Protective	Click here to enter date.

Protectiveness Statement:
The selected remedy for OU1 currently protects human health and the environment because exposure pathways that could result in unacceptable risks have been addressed. No one uses groundwater for drinking at or downgradient from the Site and institutional controls are in place at the downgradient residential properties to prevent installation of new groundwater wells. MNA and the operation of the GRUB area GWRS are currently being used to address groundwater contamination at the Site. However, in order for the remedy to be protective in the long term the following actions are needed: finalize institutional controls to prevent future groundwater use at the site property; collect groundwater samples from points outside of the current monitoring well network to adequately determine the full extent of the 1,4-dioxane plume; ensure all detection limits currently used to analyze groundwater COC concentrations are as low as, or lower than, all COC cleanup goals and change analytical methods used to analyze groundwater if needed. In addition, evaluations are needed to determine the cause of the increase in DNAPL in well F-55 and to determine if the GRUB area GWRS and MNA are capable of adequately addressing the sources of TCE in the TD-well area, DNAPL and SVOCs at well F-55, and 1,4-dioxane in sitewide groundwater. Based on evaluation findings, implementation of additional remedial actions may be needed.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU2	Short-term Protective	Click here to enter date.

Protectiveness Statement:
The selected remedy for OU2 currently protects human health and the environment because exposure pathways that could result in unacceptable risks have been addressed. OU2 remedial actions removed the primary sources of site contamination and have effectively reduced the migration of site-related contaminants to groundwater and surface water pathways. For the remedy to be protective over the long term, for areas of the site facility property where residual soil contamination remains, finalize institutional controls to prevent exposure to residual source area soil contamination and prevent activities that could compromise the integrity of the selected remedy in the future. Documentation of the need for institutional controls in a decision document is also needed.

Sitewide Protectiveness Statement

Protectiveness Determination:	*Addendum Due Date (if applicable):*
Short-term Protective	Click here to enter date.

Protectiveness Statement:
Because the remedies for OU1 and OU2 are protective in the short term, the sitewide remedy is currently protective. For the remedy to be protective over the long term, the issues identified for OU1 and OU2 need to be addressed.

Five-Year Review Summary Form (continued)

Environmental Indicators
- Current human exposures at the Site are under control. *- Current groundwater migration is under control.*

Are Necessary Institutional Controls in Place?
☐ All ☒ Some ☐ None

Has EPA Designated the Site as Sitewide Ready for Anticipated Use?
☐ Yes ☒ No

Has the Site Been Put into Reuse?
☒ Yes ☐ No

Sixth Five-Year Review Report
for
Celanese Corporation (Shelby Fibers Operations) Superfund Site

1.0 Introduction

The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy will continue to be protective of human health and the environment. FYR reports document FYR methods, findings and conclusions. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency prepares FYRs pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA Section 121 states:

> If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each 5 years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.

The EPA interpreted this requirement further in the NCP, 40 Code of Federal Regulations (CFR) Section 300.430(f)(4)(ii), which states:

> If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after initiation of the selected remedial action.

Skeo Solutions, an EPA Region 4 contractor, conducted the FYR and prepared this report regarding the OU1 and OU2 remedies implemented at the Celanese Corporation (Shelby Fibers Operations) Superfund site in Grover, Cleveland County, North Carolina. Skeo Solutions conducted this FYR from November 2015 to August 2016. The EPA is the lead agency for developing and implementing the remedy for the potentially responsible party (PRP)-financed cleanup at the Site. The North Carolina Department of Environmental Quality (NCDEQ), as the support agency representing the State of North Carolina, has reviewed all supporting documentation and provided input to the EPA during the FYR process.

This is the sixth FYR for the Site. The triggering action for this statutory review is the previous FYR. The FYR is required because hazardous substances, pollutants or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure. The Site consists of two operable units (OUs). This FYR report addresses both site OUs.

2.0 Site Chronology

Table 1 lists the dates of important events for the Site.

Table 1: Chronology of Site Events

Event	Date
Joint venture of Celanese Corporation (Celanese) and Imperial Chemicals, Inc. began manufacturing operations at the Site	1960
Site owners stored drums of waste chemicals and solvents on site	1970-1978
Celanese contractor Soil & Material Engineers, Inc. (S&ME) performed site investigations	October 1981
Celanese bought out the facility	1983
The EPA proposed the Site for listing on the Superfund program's National Priorities List (NPL)	October 15, 1984
Celanese initiated the remedial investigation/feasibility study (RI/FS) for OU1 and OU2	February 15, 1986
The EPA issued Administrative Order on Consent to PRP to perform the RI/FS	March 10, 1986
The EPA placed the Site on the NPL	June 10, 1986
Celanese completed the sitewide RI	June 1987
Celanese completed the OU1 FS	February 26, 1988
The EPA signed Record of Decision (ROD) selecting remedy for OU1	March 23, 1988
Celanese began the remedial design for OU1	June 30, 1988
Celanese completed OU1 remedial design	October 20, 1988
The EPA and Celanese entered into a Consent Decree for OU1 cleanup	October 21, 1988
Celanese began remedial action for OU1	October 24, 1988
Celanese completed the OU2 FS	January 27, 1989
The EPA signed ROD selecting remedy for OU2	March 28, 1989
Celanese began remedial design for OU2	June 19, 1989
The EPA and Celanese entered into a Consent Decree for OU2 cleanup	November 24, 1989
Celanese began OU2 remedial action	September 24, 1990
The EPA completed Preliminary Close-Out Report for OU1 and OU2	March 25, 1993
The EPA completed OU1 Remedial Action Report	June 24, 1993
The EPA completed OU2 Remedial Action Report	June 30, 1993
Celanese completed remedial action for OU1 and OU2	July 2, 1993
The EPA completed Site's first FYR (OU1)	September 8, 1994
The EPA completed Site's second FYR (OU2)	December 4, 1995
The EPA completed a partial deletion of the Site from the NPL (OU2 and portions of OU1)	April 17, 1998
The EPA completed the third FYR (sitewide)	August 29, 2001
The EPA issued Explanation of Significant Differences (ESD) for OU1	April 23, 2004
The EPA completed Site's fourth FYR (sitewide)	August 24, 2006
The EPA completed Site's fifth FYR (sitewide)	August 31, 2011
Glycol recovery unit bottom (GRUB) area groundwater recovery system (GWRS) became fully operational	December 2012

3.0 Background

3.1 Physical Characteristics

The Site is located in Grover, Cleveland County, in southern North Carolina (Figure 1). The 450-acre area consists of a main plant production area, a wastewater treatment area, former waste disposal areas, and recreational and wooded areas. The plant production area includes buildings and paved and graveled areas. The wastewater treatment area consists of grassy areas and roads (Figure 2). The recreation area is wooded and vacant. CNA Holdings, Inc. (CNA), a subsidiary of the Celanese Corporation (Celanese), owns the site property (Cleveland County parcel number 4512). Celanese is the site's PRP and is responsible for environmental work at the Site. Ticona, another Celanese subsidiary, owns and operates an active manufacturing facility at the Site. The Site is located in a predominantly rural area in Cleveland County. Surrounding land uses include residential and agricultural land uses. North Carolina Highway 198 borders the Site to the west.

The nearest surface water bodies include an on-site pond referred to as the "recreation pond" just south of the plant production area and Streams A, B and C (Figure 4). The streams discharge to a larger northwest-southeast trending unnamed tributary to Buffalo Creek traversing the eastern portion of the Site. Buffalo Creek is located about 7,400 feet southeast of the Site. It flows to the southwest and joins the larger Broad River, which flows to the southeast.

The Site is located in the Inner Piedmont Physiographic Province of the southern Appalachian Mountains. Site geology primarily consists of low permeable saprolite overlying bedrock. The saprolite is generally thickest beneath the plant and thins toward the east and in the vicinity of adjacent streams. Groundwater is present in the saprolite under unconfined, or water table conditions and in fractures of the bedrock. The direction of groundwater movement in the shallow saprolite zone is to the east, northeast, and southeast toward discharge areas along unnamed tributaries of Buffalo Creek. Groundwater in the deeper saprolite and upper bedrock zone flows in the same general direction.

3.2 Land and Resource Use

Fiber Industries, Inc., a joint venture of Celanese and Imperial Chemicals, Inc., operated at the Site from 1960 until 1983, when Celanese became sole owner of the facility. Manufacturing operations included the production of polyester polymer chips and filament yarn. Ticona continues to operate a specialty polymer plant at the Site, manufacturing engineering resins for use in a variety of industries. DuraFiber manufactures sewing thread in one of the on-site buildings. Several smaller contractors operate at the Site; they provide support services for Ticona. Land uses surrounding the Site include residential and agricultural uses. They are not expected to change in the future.

The groundwater aquifer underlying the Site is not currently used as a drinking water source. In 1995, Celanese connected nearby off-site residences to Cleveland County's municipal water system.

3.3 History of Contamination

In April 1960, manufacturing operations for the production of polyester polymer chips and filament yarn began at the Site. The primary chemicals involved in the polymer production process included dimethyl terephthalate and ethylene glycol. Other additives used in small quantities during the process included titanium dioxide and antimony.

Fiber Industries, Inc. constructed a wastewater treatment plant (WWTP) concurrently with the manufacturing plant. During early production years, facility operations included the discharge of chemical wastes through a drainage ditch that began near the western edge of an area now known as the former drum storage area. The chemical waste traveled east to the area that is now the northeast corner of the emergency spill ponds (Figure 2). When the WWTP became fully operational in the mid-1960s, the drainage ditch was replaced with pipes. The treated effluent from the WWTP is currently piped to a discharge point on Buffalo Creek. An NCDEQ permit covers this discharge.

Site operators previously used several areas around the plant for waste disposal. Facility operations included disposal of plant wastes (primarily polyester and miscellaneous trash) in old burn pits just north of the on-site aeration basins. A former drum storage and staging area is located west of the former glycol recovery unit bottom (GRUB) area (Figure 2). Facility operations in the early 1960s included the storage of failed process solutions in drums in this area. The site owners removed the drums in the mid-1960s and backfilled the area. During the 1960s, plant operators buried GRUBs in trenches north and east of the former burn pits. From 1960 to 1969, plant operations also included the storage of treated sanitary sewage in two ponds west of the existing aeration basins. In 1973, the plant expanded to include a polishing pond, two emergency spill ponds and an additional aeration basin.

Facility operations also included burial of plant wastes in four areas north and outside of the main plant perimeter fence. The polymer and fiber landfill contains primarily non-hazardous inert materials such as excavation soil, polymer and waste yarn. The construction debris landfill contains items such as old cinder blocks and steel strapping bands. In 1978, the facility held state-issued permits to dispose of wastewater sludge on about 21 acres of the northwest quadrant of the Site.

From 1970 to 1978, facility operations included the temporary storage of about 2,000 to 3,000 drums of waste chemicals and solvents in the area known as the drum storage area near the former burn pits. Site owners removed all drums from the area by 1978 for off-site disposal.

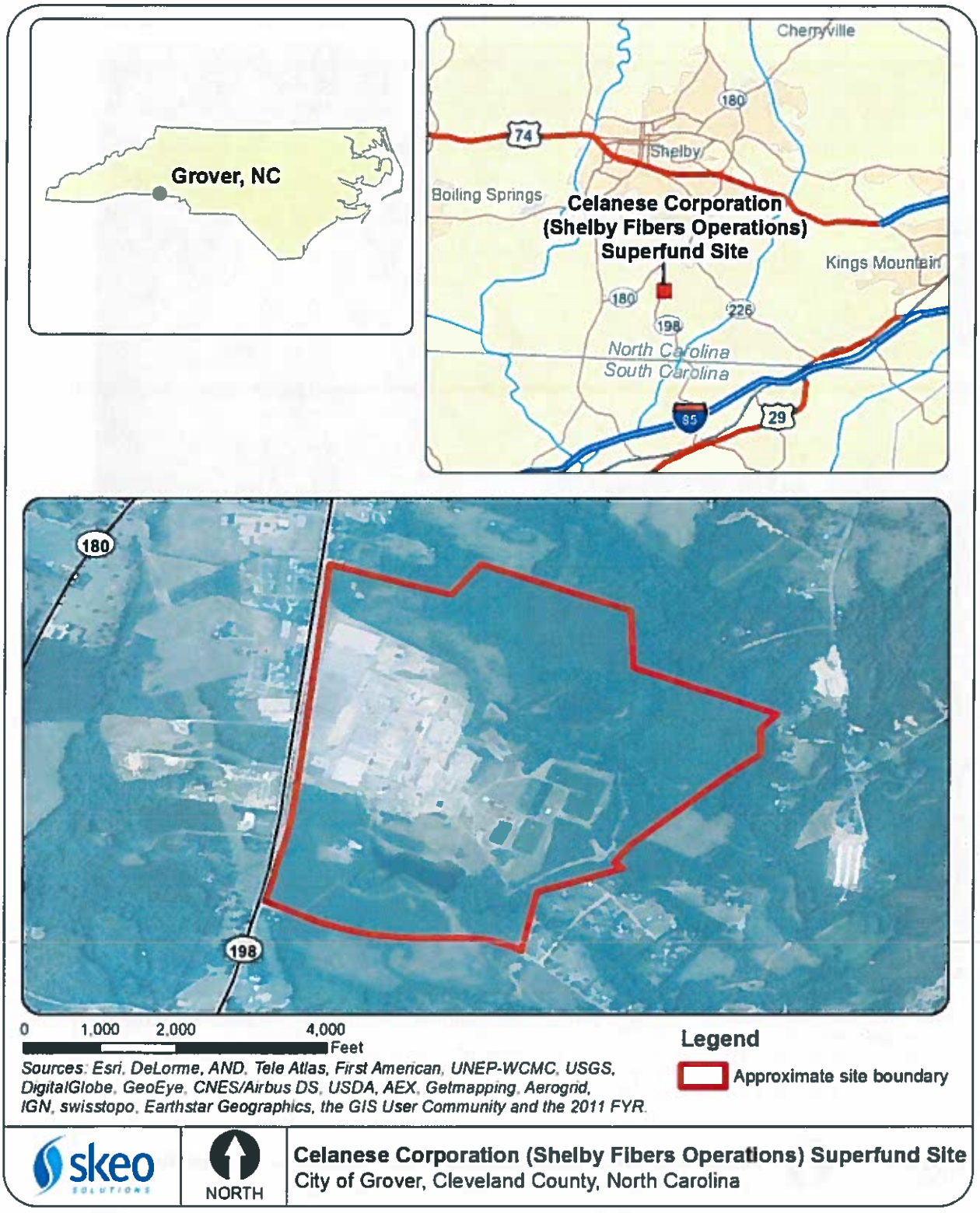
3.4 Initial Response

Site investigations began in October 1981, when Celanese contracted Soil & Material Engineers, Inc. (S&ME) to install 23 groundwater monitoring wells. In conjunction with the groundwater monitoring well installation program, S&ME also conducted a hydrogeologic evaluation. Celanese initiated a groundwater sampling and analysis program under the supervision of Davis & Floyd Laboratories, Inc. S&ME also conducted an electromagnetic survey and excavated test pits at the Site.

In March 1986, Celanese signed an Administrative Order on Consent with the EPA for the Site's remedial investigation and feasibility study (RI/FS). The EPA placed the Site on the Superfund program's National Priorities List (NPL) in June 1986.

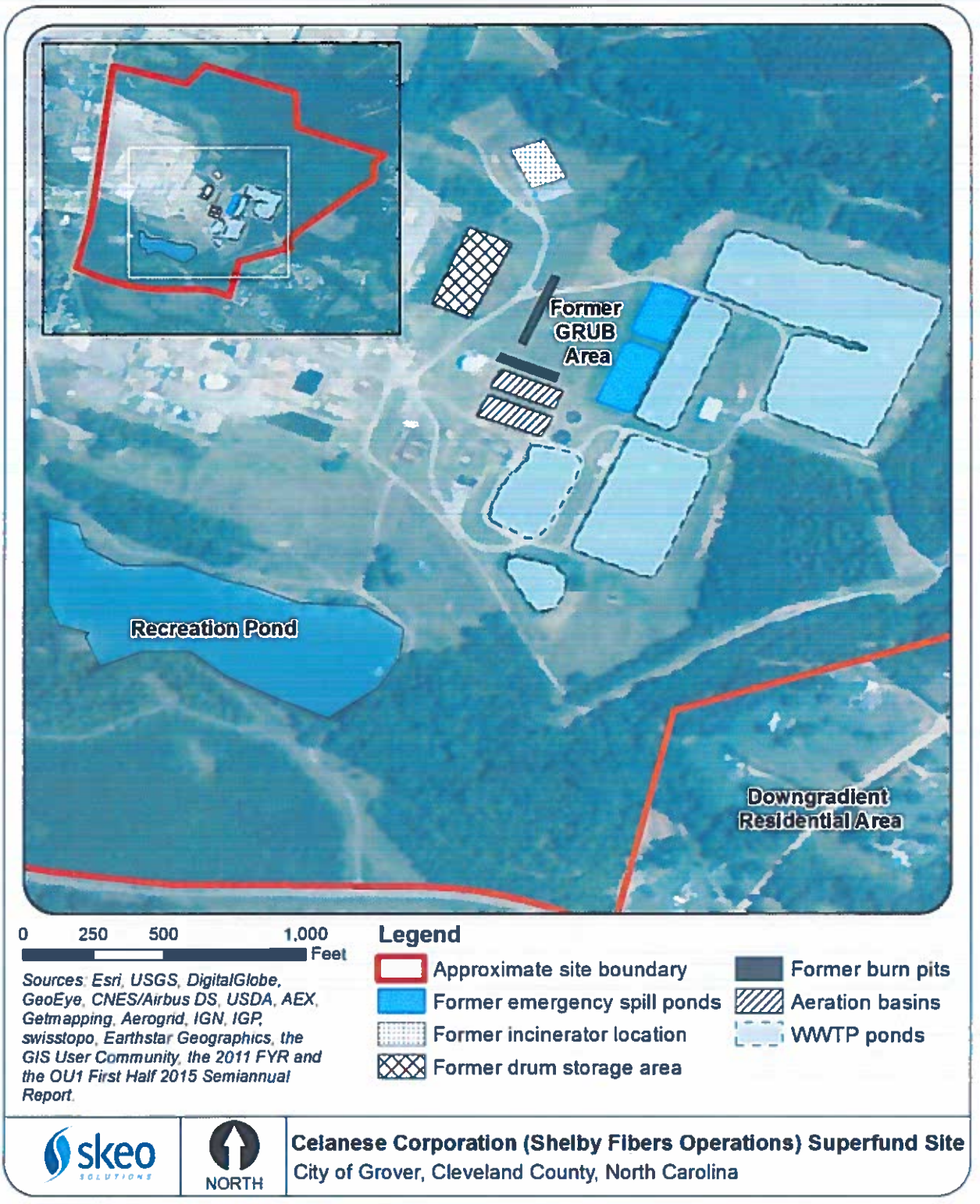
In 1995, Celanese connected nearby off-site residences to Cleveland County's municipal water system. Celanese also abandoned domestic water supply wells considered to be at potential risk of exposure to groundwater contamination and entered into water supply agreements with all downgradient residents. See Section 6.3, Institutional Control Review for additional information.

Figure 1: Site Location Map



Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding the EPA's response actions at the Site.

Figure 2: Detailed Map of Former and Current Site Features



Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding the EPA's response actions at the Site.

3.5 Basis for Taking Action

Celanese completed the Site's RI in June 1987. The PRP completed the FS to investigate groundwater contamination in March 1988 and the FS to investigate soil contamination in March 1989. The RI identified the former GRUB sludge burial area and former burn pits as the primary sources of site contamination. The RI also identified other isolated areas of soil and groundwater contamination around the periphery of the WWTP.

The RI identified several groundwater contaminants in monitoring wells that exceeded North Carolina groundwater standards, established in the North Carolina Administrative Code (15A NCAC 2L .0202). These contaminants included 1,1-dichloroethane, 1,1-dichloroethylene, trans-1,2-dichloroethylene, benzene, methylene chloride, vinyl chloride, chloroform, chlorobenzene, chloromethane, carbon tetrachloride, phenols, tetrachloroethylene (PCE), trichloroethylene (TCE), chlordane, chromium, barium, iron, manganese, nickel and selenium. Contaminants detected in site soils and waste included phthalates, benzene and other non-phenolic aromatic compounds, polycyclic aromatic hydrocarbons (PAHs), phenol, ketone compounds and dibenzofuran.

The 1988 FS identified the potential for source area contaminants to leach directly into the underlying groundwater and enter surface water streams by erosion and overland flow. The RI determined that soil contamination extended more than 30 feet below land surface at source areas.

A health assessment, performed as part of the RI/FS, investigated potential exposure pathways at the Site. The assessment concluded that direct exposure to contaminated groundwater posed an unacceptable risk to human health.

The health assessment indicated that aquatic life could experience toxic effects from exposure to bis(2-ethylhexyl)phthalate and chromium in the surface water.

4.0 Remedial Actions

In accordance with CERCLA and the NCP, the overriding goals for any remedial action are protection of human health and the environment and compliance with applicable or relevant and appropriate requirements (ARARs). A number of remedial alternatives were considered for the Site, and final selection was made based on an evaluation of each alternative against nine evaluation criteria that are specified in Section 300.430(e)(9)(iii) of the NCP. The nine criteria are:

1. Overall Protection of Human Health and the Environment
2. Compliance with ARARs
3. Long-Term Effectiveness and Permanence
4. Reduction of Toxicity, Mobility or Volume through Treatment
5. Short-Term Effectiveness
6. Implementability
7. Cost
8. State Acceptance
9. Community Acceptance

4.1 Remedy Selection

Based on investigation findings, the EPA divided the Site into two OUs to manage the cleanup. OU1 addressed groundwater contamination. OU2 addressed soil contamination and source wastes at the GRUB area and burn pits, as well as impacted sediment in one section of streambed.

OU1

The EPA selected the remedy to address groundwater contamination in the Site's March 1988 OU1 Record of Decision (ROD). The OU1 ROD did not establish remedial action objectives (RAOs). The Site's 1988 FS Report stated that remedial alternatives were developed to eliminate or reduce the waste source and abate contaminant migration through groundwater and surface water pathways. The OU1 ROD requires removal of all compounds detected in groundwater above maximum contaminant levels (MCLs) or North Carolina 2L standards (whichever is more stringent), which are not naturally occurring, "until the concentration of that compound has fallen below the lowest analytical method detection limit published by EPA for that particular compound."

The remedy selected in the OU1 ROD consisted of:

- Installation of extraction wells (referred to as outer tier (OT) wells) into bedrock at the perimeter of the Site.
- Installation of shallow extraction wells (referred to as inner tier (IT) wells) directly downgradient of the source area.
- Pumping of contaminated water from IT wells to a common holding tank, through an inclined plate separator for iron removal, to a biological sequencing batch reactor, through an air stripper, and then through a granulated activated carbon canister prior to discharge to the plant's polishing pond system.
- Pumping of contaminated groundwater from OT wells to a common holding tank, through an air stripper, and then through a granulated activated carbon canister prior to discharge to the plant's polishing pond system.
- Discharge of treated groundwater to the existing wastewater treatment system, as long as current National Pollutant Discharge Elimination System (NPDES) permit limitations are not violated.

The 1988 ROD did not establish contaminants of concern (COCs) for groundwater. The RI defined indicator chemicals as those chemicals present on site representing the greatest potential human health hazard. The health assessment identified benzene, TCE, bis(2-ethylhexyl)phthalate, lead and chromium as indicator chemicals for groundwater. Table 2 lists the groundwater indicator chemicals and the cleanup goals established in the 1988 ROD. The OU1 ROD requires removal of all compounds detected in groundwater above MCLs or North Carolina 2L standards. That requirement results in a changing list of groundwater COCs as additional contaminants occasionally exceed their respective cleanup goals. Since 1988, concentrations of several other groundwater contaminants, in addition to the indicator chemicals listed in Table 2, have exceeded MCLs and/or North Carolina 2L standards. See Section 6.3 for additional details.

Table 2: Groundwater Indicator Chemical Cleanup Goals

Groundwater Indicator Chemicals	1988 ROD Cleanup Goal[a] (mg/L)
Benzene	0.0007
TCE	0.0028
Bis(2-ethylhexyl)phthalate	NA
Lead	0.05
Chromium	0.05

Notes:
a. These 1988 standards were proposed standards obtained from a draft of a document by the State of North Carolina identified in the 1988 Final FS Report completed for OU1.
mg/L = milligrams per liter

In April 2004, the EPA modified the OU1 ROD remedy with an Explanation of Significant Differences (ESD). The ESD allowed a 24-month shutdown of the Site's groundwater treatment system to allow the aquifer to recover and to provide an opportunity to investigate the effectiveness of monitored natural attenuation (MNA) as an alternative remedy to address remaining groundwater contamination. The ESD also modified the treatment approach to remove the freestanding groundwater treatment system from the remedy and allow groundwater to pump directly to the headworks of the existing industrial WWTP for biological treatment.

OU2

The EPA selected a remedy to address source contamination in the Site's March 1989 OU2 ROD. The OU2 ROD did not establish RAOs. The Site's 1989 FS Report stated that remedial alternatives were developed to remove the primary source of contamination to minimize the spread of contaminants into groundwater.

The remedy selected in the OU2 ROD consisted of:

- Excavation of GRUB sludge, plastic chips, burn pit residuals and stream sediments.
- On-site incineration of contaminated soils and GRUB sludge.
- Chemical fixation (solidification) of incinerator ash, plastic chips, burn pit residuals and stream sediments.
- On-site disposal of inert, solidified material.
- Regrading.
- Monitoring.

The OU2 remedy was not designed to remove all source contamination, due to its depth and the difficulty of excavating the material. The OU2 ROD did not establish cleanup goals for soil at the Site. The OU2 remedy design anticipated that the OU1 groundwater treatment system would treat any residual source area contamination left in place following the completion of the OU2 remedial action.

4.2 Remedy Implementation

OU1

Celanese agreed to perform OU1 remedial actions in a partial Consent Decree dated June 1988. The EPA approved the remedial design for OU1 in October 1988. Celanese began construction of the groundwater extraction and treatment system later that month. The system became operational in August 1989. The EPA documented the completion of remedy implementation at OU1 in the Site's June 1993 Remedial Action Report.

The groundwater extraction and treatment system originally consisted of a two-tier extraction well system on site. IT wells are located adjacent to, and hydraulically downgradient from, the source waste areas. OT wells are located near the southern and eastern boundaries of the site property.

By the late 1990s, the OT wells showed low and non-detectable COC concentrations. The OT portion of the treatment system operated until April 21, 1998, when the EPA approved its shutdown as part of a partial deletion petition. The petition deleted the OT extraction and treatment system along with the OU2 source remediation area from the NPL.

Per the 2004 ESD, Celanese shut down the IT treatment system in March 2004 to enable the performance of a 24-month MNA demonstration project. The 24-month period ended in March 2006. The PRP submitted a request to the EPA to extend the MNA demonstration period to March 2007. The EPA approved the extension in June 2006. During a September 2006 meeting, the EPA, the North Carolina Department of Environment and Natural Resources (NCDENR, now the NCDEQ), Celanese and PRP contractor Earth Tech agreed that a transition to MNA appeared to be an appropriate remedy for site groundwater. The decision was not documented in a decision document.

In 2007, the EPA determined that additional characterization of site contamination would be beneficial. In 2009, EPA contractor GeoTrans, Inc. conducted an independent review of the OU1 remedy and presented the evaluation of the remedy in an Independent Design Review (IDR). The IDR determined that the IT treatment system operated with minimal effectiveness, and attributed this to the system's low extraction yield in relation to the amount of water flowing through the aquifer. As a result, the mass control and source recovery offered by the system were likely negligible. Another potential cause for the system's minimal effectiveness was that the extraction wells were not optimally placed relative to the areas where source contamination remains in place at the Site.

To further characterize site contamination, evaluate the effectiveness of the remedy and determine the best way to address remaining contamination at the Site, PRP contractors developed the Work Plan and Field Sampling Plan for Supplemental Investigation and Long-Term Groundwater Monitoring in June 2010. Investigations of the former GRUB disposal area revealed elevated concentrations of ethylene glycol and 1,4-dioxane in groundwater. To address those, and other site-related source area contaminants, the PRP installed a groundwater recovery extraction system in 2012, referred to as the GRUB area groundwater recovery system (GWRS). The system includes three extraction wells – IT-10, IT-11 and IT-12 – and associated infrastructure. The system became fully operational in December 2012. The PRP has operated the system continuously since that time.

The GWRS pumps contaminated groundwater from the former GRUB disposal area to the headworks of the facility's WWTP. The WWTP treats the extracted groundwater with the wastewater generated by facility operations. The wastewater treatment process includes movement of water from the headworks

to equalization basins A through C, then to aeration basins south and north, then to clarifier basins, clay-lined ponds A through C, and then through tertiary filters. The system discharges treated water to Buffalo Creek. The facility's NPDES permit regulates the discharge of water to Buffalo Creek. Celanese routinely monitors the effluent from the WWTP per NPDES permit requirements and submits monthly reports to NCDEQ summarizing monitoring results.

PRP contractor AECOM periodically monitors 10 performance monitoring wells (CC-64, IT-5, IT-6, IT-7, IT-8R, IT-9, K-28, K-58, V-23 and V-65) to monitor the effectiveness of the groundwater extraction system.

OU2

Celanese agreed to perform OU2 remedial actions in a Consent Decree dated June 1989. The EPA approved the remedial design for OU2 in September 1990. Celanese performed the remedial action for OU2 between January 1991 and September 1992. A summary of activities completed during the remedial action included:

- Excavation of 4,529 tons of GRUB sludge underlying native soil.
- Excavation of 3,259 tons of burn pit residuals and plastic chips.
- Excavation of between 39 and 54 cubic yards of stream sediments from two intermittent streams north of the OU2 source areas.
- Incineration of GRUB sludge, soil, burn pit residuals, plastic chips, stream sediments and wastewater treatment plant solids in an on-site rotary kiln.
- Solidification of the incinerated wastes on site.
- On-site disposal of the stabilized materials in the excavated pits located in the vicinity of the former GRUB area (Figure 2).
- Backfilling, regrading and revegetation of the pit areas.

The PRP completed streambed remediation in May 1991. Following removal of contaminated sediments, the PRP performed confirmatory sampling. Sampling results showed concentrations of PAHs above EPA screening values. At that time, the EPA determined that additional remediation would be detrimental to the streambed. In May 1992, EPA's Region 4 Office of Health Assessment issued a memo stating that the stream's biological communities should be allowed to recover from the remediation efforts prior to any further testing or remediation efforts. The memo recommended performing a reevaluation of the stream ecology as part of the next OU2 FYR. As part of the 1995 FYR, PRP contractor Shealy Environmental Services, Inc. performed a biological survey of the remediated site streams. The survey verified that the streams had recovered from OU2 remedial activities. The survey also concluded that the increased biological diversity observed downstream of the remediated areas indicated that substances toxic to those communities are not present in the water or stream sediments.

The PRP operated the on-site incinerator from April 1991 to December 1991. Full-scale solidification, placement of solidified materials in excavation pits and backfilling of the affected areas took place from June 1991 to September 1992. The former location of the incinerator is shown in Figure 2.

The EPA selected the source control soil remedy to address leaching of contaminants to groundwater. Because the OU2 remedy was designed only to remove major areas of source contamination, subsurface sampling was not conducted for confirmation purposes during the implementation of the remedy. The ROD required the excavation of source area materials to at least two feet below the waste-soil interface

until no visible contamination remains. According to the OU1 ROD, the OU1 remedy would address residual contamination below the excavation depth. As required by the OU2 ROD, Celanese performed environmental monitoring and sampling activities throughout OU2 cleanup activities to assess remedial action performance. These activities included air, incinerator gas stack and wastewater monitoring, and toxicity characteristic leaching procedure testing of all stabilized material disposed of in the excavated pits. Toxicity characteristic leaching procedure results verified that the incinerated and stabilized materials passed regulatory standards. No additional sampling has been conducted for the OU2 remedy since implementation.

In March 1993, the EPA documented the completion of remedy construction for OU1 and OU2 in the Site's Preliminary Close-Out Report. On April 17, 1998, the EPA deleted the former source area, the remediated streams of OU2, and the OT groundwater extraction well system and associated treatment systems for OU1 from the NPL. The EPA deleted OU2 and the OT components of the OU1 remedy from the NPL after confirming that CERCLA response activities as outlined in the 1989 ROD and the OU2 remedy were found to be protective of human health and the environment.

4.3 Operation and Maintenance (O&M)

The Site's original groundwater treatment system has not been in operation during this FYR period; the system has not operated since being shut down to enable the MNA pilot study in 2004. However, PRP contractor AECOM continues to maintain the IT treatment system in the event that the system is returned to use. AECOM performs semiannual groundwater and surface water sampling per the June 2010 Work Plan and Field Sampling Plan for Supplemental Investigation and Long-Term Groundwater Monitoring. AECOM inspects monitoring and extraction wells during sampling events and makes repairs as needed.

The GRUB Area GWRS began operating during the first week of October 2012. Since system startup, well IT-10 has not operated efficiently compared to wells IT-11 and IT-12. A minimal amount of water has been extracted from IT-10 since April 2013 when the well was shut down for about two months to evaluate the impact of extraction from the other wells. The operation efficiency of well IT-10 has increased since 2014. Since startup, the system has removed about 339,251 gallons of groundwater, 87,830 pounds of chemical oxygen demand (COD), 11 pounds of 1,4-dioxane and 12,743 pounds of ethylene glycol (EG).

The 1988 ROD for OU1 estimated that O&M costs to operate the groundwater treatment system would be about $1,100,000 for a 30-year period, or about $37,000 annually. Because the original groundwater treatment system is no longer in operation, and MNA and the new groundwater extraction system are currently being used to address groundwater contamination at the Site, a direct comparison of actual O&M costs and estimated costs is not appropriate. Table 3 provides the actual costs for O&M during the past five years. Annual costs between 2011 and 2015 include groundwater and surface water sampling and reporting, 2011 FYR support costs, costs associated with the installation of additional TD-area monitoring wells, and installation and startup of the GRUB area extraction well system. See Section 6.4, Data Review for additional information regarding TD-area wells.

2011 FYR support costs resulted in higher-than-average O&M costs in 2011. TD-area well installation and installation of the GRUB area groundwater extraction system resulted in atypically high O&M costs in 2012. The 2013 O&M costs include extensive system monitoring performed during the startup of the

extraction system. Costs in 2014 and 2015 are more representative of current, typical annual O&M costs.

Table 3: Annual O&M Costs

Year	Total Cost
2011	$327,000
2012	$520,000
2013	$238,000
2014	$140,000
2015	$215,000

5.0 Progress Since the Last Five-Year Review

The protectiveness statement from the 2011 FYR for the Site stated:

The Site's remedy for OU1 currently protects human health and the environment in the short term. Institutional controls prohibiting ground water use are in place at residential properties downgradient of the facility property and these properties are connected to the municipal water supply. Ground water is also not in use on site. Therefore, there are currently no completed exposure pathways at the Site. MNA and long-term monitoring are currently being used to address remaining ground water contamination at the Site and their effectiveness is being evaluated. The IDR determined that MNA may not sufficiently address all contaminants detected at the Site, including diethylene dioxide and TCE. Because MNA may not address all contamination remaining at the Site, ground water extraction should resume and the placement of extraction wells in the system should be evaluated to determine the most appropriate locations to be able to adequately remove the remaining contamination.

The Site's remedy for OU2 currently protects human health and the environment in the short term. The area of source contamination addressed under OU2 at the Site has been regraded and revegetated following excavation and treatment of source contamination, as required by the selected remedy. Following remediation activities, EPA concluded that the OU2 remedy was protective of human health and the environment because the major source of contamination was removed and residual contamination that leaches into ground water would be addressed by the OU1 ground water remedy. OU2 was deleted from the NPL. Because contaminated soil and ground water remain on the facility property, institutional controls are needed to ensure that remaining contamination in the source areas is not disturbed.

For the Site's remedy to be protective in the long term, the remedy needs to be updated to ensure it effectively addresses remaining ground water contamination; remaining contamination at the Site needs to be completely characterized; and the potential for migration of diethylene dioxide off the facility property needs to be addressed. Additionally, institutional controls are needed on the facility property to limit future uses of ground water and the source area, and to ensure that the integrity of the selected remedy is not compromised in the future.

The 2011 FYR included six issues and recommendations. This report summarizes each recommendation and its current status below.

Table 4: Progress on Recommendations from the 2011 FYR

Recommendations	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
Evaluate whether the current extraction wells can capture remaining contamination while a final decision is made in regards to updating the remedy in order to address remaining groundwater contamination at the Site.	PRP and EPA	08/24/2012	Ongoing. The PRP installed a new groundwater extraction system in 2012 to help address remaining contamination. The system includes three extraction wells – IT-10, IT-11 and IT-12 – and associated infrastructure. However, based on groundwater data reviewed as part of this FYR, additional evaluation is needed to determine if the GRUB area GWRS and MNA are capable of adequately addressing the sources of TCE in the TD-well area, DNAPL and SVOCs at well F-55, and 1,4-dioxane in sitewide groundwater. See Section 6.4 for additional details.	N/A
Resume groundwater extraction and treatment.	PRP and EPA	08/24/2012	Completed. The PRP installed a new groundwater extraction system in 2012 to help address remaining contamination. The system includes three extraction wells – IT-10, IT-11 and IT-12 – and associated infrastructure.	12/01/2012*
Update site documents to reflect the more stringent ARARs for lead, chromium, barium and nickel.	PRP and EPA	08/24/2012	Considered and not implemented. According to the ROD, any groundwater constituent that exceeds the North Carolina 2L groundwater standard or MCL is considered a groundwater COC. The way the ROD is phrased, groundwater cleanup goals for the Site change as the North Carolina 2L standards change. Groundwater ARARs for lead, chromium, barium and nickel have become more stringent since the 1988 OU1 ROD and the 1987 RI. There is not a need to update groundwater cleanup goals in a decision document. Celanese compares groundwater monitoring data to current North Carolina 2L standards, as they are more stringent than MCLs.	03/21/2016

Recommendations	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
Update site decision documents to include institutional controls and implement them to limit the future use of groundwater and the source area at the Site, and to ensure that the integrity of the selected remedy is not compromised in the future.	PRP	08/24/2012	Ongoing. The site decision documents have not yet been updated to require institutional controls. However, the PRP and NCDEQ have drafted a Declaration of Perpetual Land Use Restrictions to meet the need for institutional controls. The EPA has approved the Declaration. The document is awaiting final approval from the Assistant General Counsel for the North Carolina DEQ.	N/A
Determine the source and fully characterize the extent of diethylene dioxide (1,4-dioxane) contamination at the Site and develop follow-up actions to address remaining contamination and mitigate the migration of contamination from the Site.	PRP	08/24/2012	Ongoing. AECOM performed an expanded sampling program in September 2010 and March 2011 to help determine the source and characterize the extent of 1,4-dioxane contamination at the Site. The constituent is also monitored during semi-annual sampling events. Sampling has identified two primary sources of 1,4-dioxane at the Site. See Section 6.4 for additional details. The new groundwater extraction system helps address the source of the 1,4-dioxane in site groundwater. However, the full extent of 1,4-dioxane contamination in site groundwater has not been fully defined.	N/A
Determine the TCE source in wells HH-48 and HH-77 and determine if follow-up actions will be needed to address remaining TCE contamination at these wells.	PRP	08/24/2012	Completed. Expanded sampling efforts in September 2010 and March 2011 found no connection between TCE concentrations in site groundwater and TCE in wells HH-48 and HH-77. A limited vapor intrusion assessment by the EPA in May 2011 concluded that vapor intrusion does not pose an unacceptable risk to human health for the residence located near wells HH-48 and HH-77. See Appendix I for additional details.	05/20/2011

Note:
* The 12/01/2012 "Date of Action" is used to represent the date that the GRUB Area GWRS became fully operational.
N/A – Not applicable.

6.0 Five-Year Review Process

6.1 Administrative Components

EPA Region 4 initiated the FYR in November 2015 and scheduled its completion for August 2016. EPA remedial project manager (RPM) Ken Mallary led the EPA's site review team, which also included EPA site attorney Susan Capel, EPA community involvement coordinator (CIC) Stephanie Brown and contractor support provided to the EPA by Skeo Solutions. In February 2016, the EPA held a scoping call with the review team to discuss the Site and items of interest as they related to the protectiveness of the remedy currently in place. The review schedule established consisted of the following activities:

- Community notification.
- Document review.
- Data collection and review.
- Site inspection.
- Local interviews.
- FYR Report development and review.

6.2 Community Involvement

In April 2016, the EPA published a public notice in the *Shelby Star* newspaper announcing the commencement of the FYR process for the Site, providing EPA contact information and inviting community participation. The press notice is available in Appendix B. No one contacted the EPA as a result of the advertisement.

The EPA will make the final FYR Report available to the public. Upon completion of the FYR, the EPA will place copies of the document in the designated site repository: Cleveland County Memorial Library, 104 Howie Drive, Shelby, North Carolina 28150.

6.3 Document Review

This FYR included a review of relevant site-related documents, including the RODs, ESD, remedial action reports and recent monitoring data. Appendix A provides a complete list of the documents reviewed.

ARARs Review

CERCLA Section 121(d)(1) requires that Superfund remedial actions attain "a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and of control of further release at a minimum which assures protection of human health and the environment." The remedial action must achieve a level of cleanup that at least attains those requirements that are legally applicable or relevant and appropriate.

- Applicable requirements are those cleanup standards, standards of control and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, remedial action, location or other circumstance found at a CERCLA site.

- Relevant and appropriate requirements are those standards that, while not "applicable," address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards more stringent than federal requirements may be applicable or relevant and appropriate.

- To-Be-Considered (TBC) criteria are non-promulgated advisories and guidance that are not legally binding, but should be considered in determining the necessary remedial action. For example, TBC criteria may be particularly useful in determining health-based levels where no ARARs exist or in developing the appropriate method for conducting a remedial action.

Chemical-specific ARARs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish an acceptable amount or concentration of a chemical that may remain in, or be discharged to, the ambient environment. Examples of chemical-specific ARARs include MCLs under the federal Safe Drinking Water Act and ambient water quality criteria enumerated under the federal Clean Water Act.

Action-specific ARARs are technology- or activity-based requirements or limits on actions taken with respect to a particular hazardous substance. These requirements are triggered by a particular remedial activity, such as discharge of contaminated groundwater or in-situ remediation.

Location-specific ARARs are restrictions on hazardous substances or the conduct of the response activities solely based on their location in a special geographic area. Examples include restrictions on activities in wetlands, sensitive habitats and historic places.

Remedial actions are required to comply with the chemical-specific ARARs identified in the ROD. In performing the FYR for compliance with ARARs, only those ARARs that address the protectiveness of the remedy are reviewed.

Groundwater

According to the 1988 OU1 ROD, groundwater ARARs are the North Carolina 2L groundwater standards (15A NCAC 2L .0202). The ROD specified that all compounds detected in groundwater that are not naturally occurring must be removed. Changes in groundwater ARARs since the OU1 ROD do not affect protectiveness because groundwater cleanup goals change as the North Carolina 2L groundwater standards change. Therefore, there is not a need to update groundwater cleanup goals in a decision document. Celanese compares groundwater monitoring data to current North Carolina 2L groundwater standards. A comparison of groundwater ARARs from the 1988 OU1 ROD to current groundwater ARARs is not needed to assess protectiveness of the groundwater remedy. For informational purposes, this FYR compared groundwater ARARs from the 1988 OU1 ROD to current ARARs. Findings of the ARARs comparison can be found in Appendix F.

Surface Water ARARs

The site RODs did not establish ARARs for surface water. Surface water monitoring results are compared to North Carolina Administrative Code, Title 15A, Subchapter 2B (NCAC 2B) surface water standards.

Soil ARARs

The Site's 1989 OU2 ROD did not establish ARARs for soil.

Institutional Control Review

Site decision documents did not require institutional controls. However, soil contamination remains in place on site at concentrations that do not allow for unrestricted use and site groundwater contains contaminants at concentrations above MCLs and North Carolina 2L groundwater standards. Institutional controls are needed for the site property to prevent exposure to contaminated groundwater and residual source contamination. They are also needed to prevent activities that could compromise the integrity of the selected remedy in the future.

Between July and September 1995, the PRP entered into water supply agreements with all downgradient residents (Figure 3). The water supply agreements run with the property deeds and act as institutional controls to prevent exposure to contaminated groundwater. In 1995, Celanese connected these properties to Cleveland County's municipal water supply, and provided financing for residents to cap and seal private wells on their properties. The agreements prohibit well drilling or the reopening of existing wells as long as a public water source is available.

Skeo Solutions staff conducted online research using the Cleveland County Register of Deeds Office website and found the water supply agreements and a Consent Decree applicable to the Site (Appendix G, Table G-1). A copy of a water supply agreement is included in Appendix G (Figure G-1).

Table 5 lists the institutional controls associated with areas of interest at the Site.

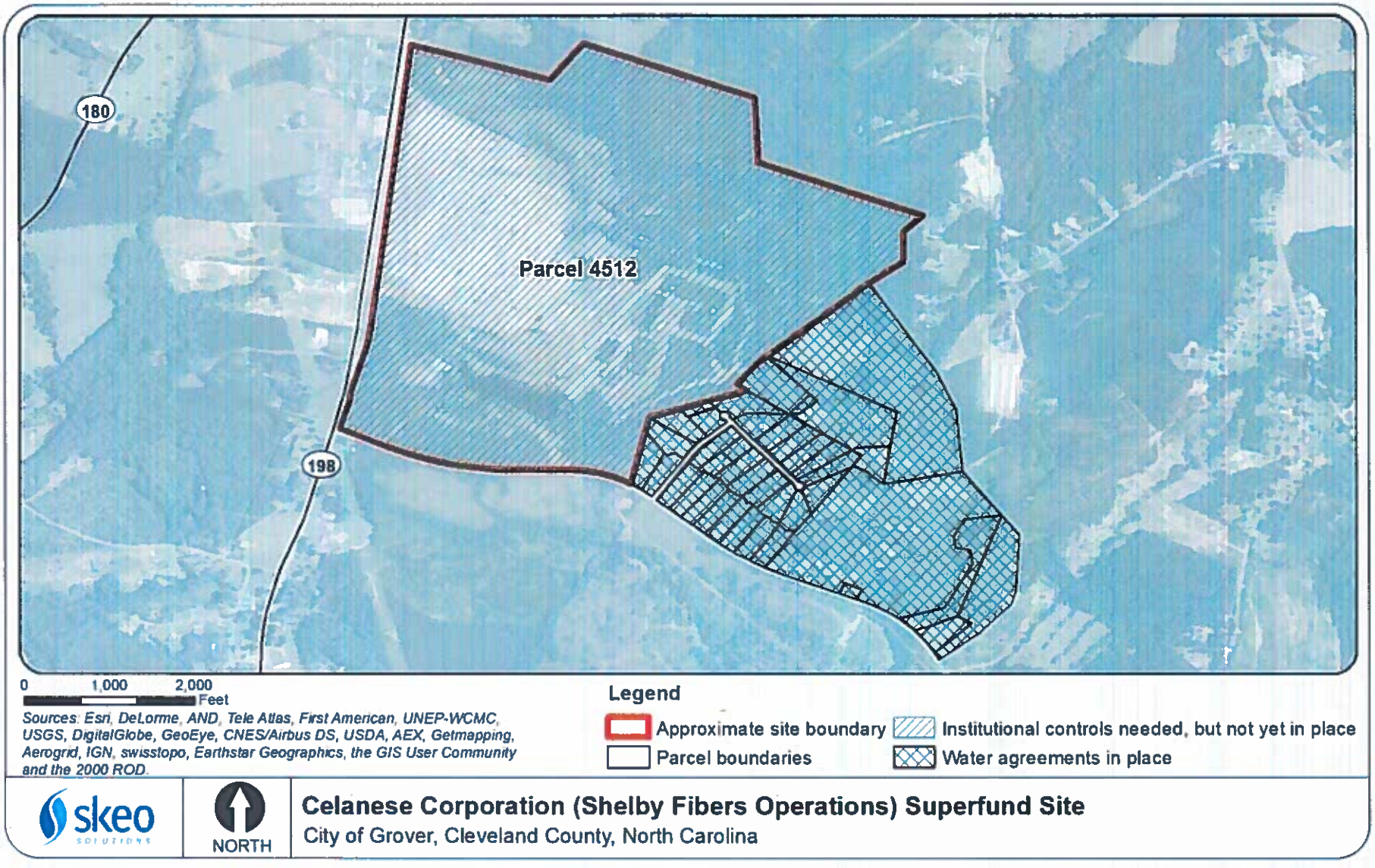
Table 5: Institutional Control (IC) Summary Table

Area of Interest – OU1 and OU2 Groundwater and Source Control						
Media	**ICs Needed**	**ICs Called for in the Decision Documents**	**Impacted Parcel(s)**	**IC Objective**	**Instrument in Place**	**Notes**
Groundwater	Yes	No	See Figure 3	Restrict installation of groundwater wells and groundwater use	Water supply agreements are in place for residences downgradient of the Site. No groundwater restrictions are currently in place for the site property.	Celanese connected residences downgradient of the Site to Cleveland County's municipal water supply. Residents agreed to cap and seal any private wells.* Future drilling or reopening of wells on the properties is prohibited as long as a public source of water is available.

Soil	Yes	No	4512	Prevent exposure to residual source area contamination and prevent activities that could compromise the integrity of the selected remedy in the future**	None	None

Notes:
* The water supply agreements for two downgradient residential properties stipulated that the property owners could retain a deep well for agricultural use on each property.
**Institutional controls to prevent exposure to residual soil contamination at the site property (parcel 4512) may not be needed for the entire property parcel. They are required for any areas where residual soil contamination is present.

Figure 3: Institutional Control Base Map



Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding the EPA's response actions at the Site.

6.4 Data Review

Groundwater

This FYR evaluated groundwater data collected during semi-annual monitoring events from March 2011 to March 2015, examining indicator chemicals and the other constituents detected above the current North Carolina groundwater standards. PRP contractor AECOM performs monitoring to evaluate the performance of MNA and of the GRUB area GWRS (Figure 4). Monitoring activities include analysis of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), 1,4-dioxane and EG for MNA monitoring wells and analysis of 1,4-dioxane, EG and COD for wells associated with the GRUB Area GWRS. AECOM compares groundwater monitoring data to current North Carolina 2L groundwater standards. Appendix I includes additional detailed data review findings.

In general, monitoring data collected between March 2011 and March 2015 indicate that concentrations of several groundwater COCs routinely exceed their respective North Carolina 2L groundwater standards and MCLs. Overall, groundwater COC concentrations tend to fluctuate sitewide, with no significant decreasing trends observed over time. These findings suggest that MNA and the operation of the GRUB area GWRS may not be capable of adequately addressing residual sources of groundwater contamination at the Site. With the possible exception of 1,4-dioxane, groundwater monitoring data suggest that groundwater COCs are not migrating off site. Monitoring data results are discussed below for groundwater COCs that routinely exceed cleanup goals.

Benzene (original ROD indicator chemical)

Between March 2011 and March 2015, benzene concentrations exceeded the North Carolina 2L groundwater standard of 0.001 mg/L at least once in 16 wells, and the benzene MCL of 0.005 mg/L at least once in 13 wells (Appendix I, Table I-2). Wells IT-7 and F-55 routinely show the highest benzene concentrations. Well IT-7 is located immediately downgradient from the former GRUB area. Well F-55 is located east of the plant production area (Figure 4). In general, since March 2011, benzene concentrations tend to fluctuate sitewide, with no significant trends observed.

TCE (original ROD indicator chemical)

Between March 2011 and March 2015, TCE concentrations exceeded both the North Carolina 2L groundwater standard of 0.003 mg/L and the MCL of 0.005 mg/L at least once in 13 wells (Table I-3). In general, since March 2011, TCE concentrations tend to fluctuate sitewide, with no significant trends observed.

Well QQ-110, located immediately adjacent to well TD-4, consistently shows the highest TCE concentrations sitewide. Monitoring well TD-4 routinely contains the second highest concentrations of TCE sitewide. Monitoring well QQ-110 is a bedrock monitoring well installed as a deep cluster well near monitoring wells TD-3 and TD-4 to delineate the vertical extent of TCE at this location. Wells TD-4 and QQ-110 are located immediately east of the eastern wall of the plant production area (Figure 4). DuraFiber operates inside the building immediately adjacent to the wells (west). The presence of TCE at concentrations high above the MCL, in close proximity to an occupied building (less than 100 feet), triggered the need to evaluate the potential for vapor intrusion at the production area building. See Section 7.2 for additional vapor intrusion discussion.

Between March and May 2012, AECOM investigated the TD well area to delineate the vertical and lateral extent of TCE in groundwater and to investigate possible sources. The investigation found that TCE concentrations in groundwater in the vicinity of TD-3 and TD-4 increase with depth. The

investigation found a lack of TCE daughter/breakdown products in the groundwater samples, indicating that TCE in the area of TD-3 and TD-4 is not degrading. TCE concentrations at wells south and southeast of the TD well cluster are consistently below the North Carolina 2L groundwater standard (wells TD-2 and I-57), indicating that the TCE plume is not migrating in that direction. TCE concentrations at well PEW-1, located northeast of the TD well area, remain elevated above state and federal standards and show a slight increase over time. These data indicate the possibility of TCE plume migration from the TD well area, toward the northeast (Figure 4).

The lack of a noticeable decreasing trend in TCE concentrations over time, and the lack of detection of daughter/breakdown products, indicates that MNA and the operation of the GWRS may not be capable of adequately addressing the source of TCE in site groundwater.

1,4-Dioxane

Between March 2011 and March 2015, 1,4-dioxane concentrations exceeded the North Carolina 2L groundwater standard of 0.003 mg/L at least once at almost all site wells (Table I-4). Data from March 2011 to March 2015 indicate there are two primary sources of 1,4-dioxane at the Site; the former GRUB disposal area and the area east of the plant production area. The highest concentrations are routinely observed at well IT-6, located immediately downgradient of the former GRUB area, and newly installed extraction wells (Figure 4). The March 2015 detections of 1,4-dioxane in samples from monitoring wells KK-55 (0.153 mg/L) and DD-58R (0.0608 mg/L) show that the impacted groundwater has migrated across the small tributaries at some locations. Even though the surface streams capture the shallow groundwater, there is some underflow in the deeper and less well-connected portions of the fracture system. Groundwater monitoring data indicate that the extent of 1,4-dioxane contamination in groundwater has not been fully defined.

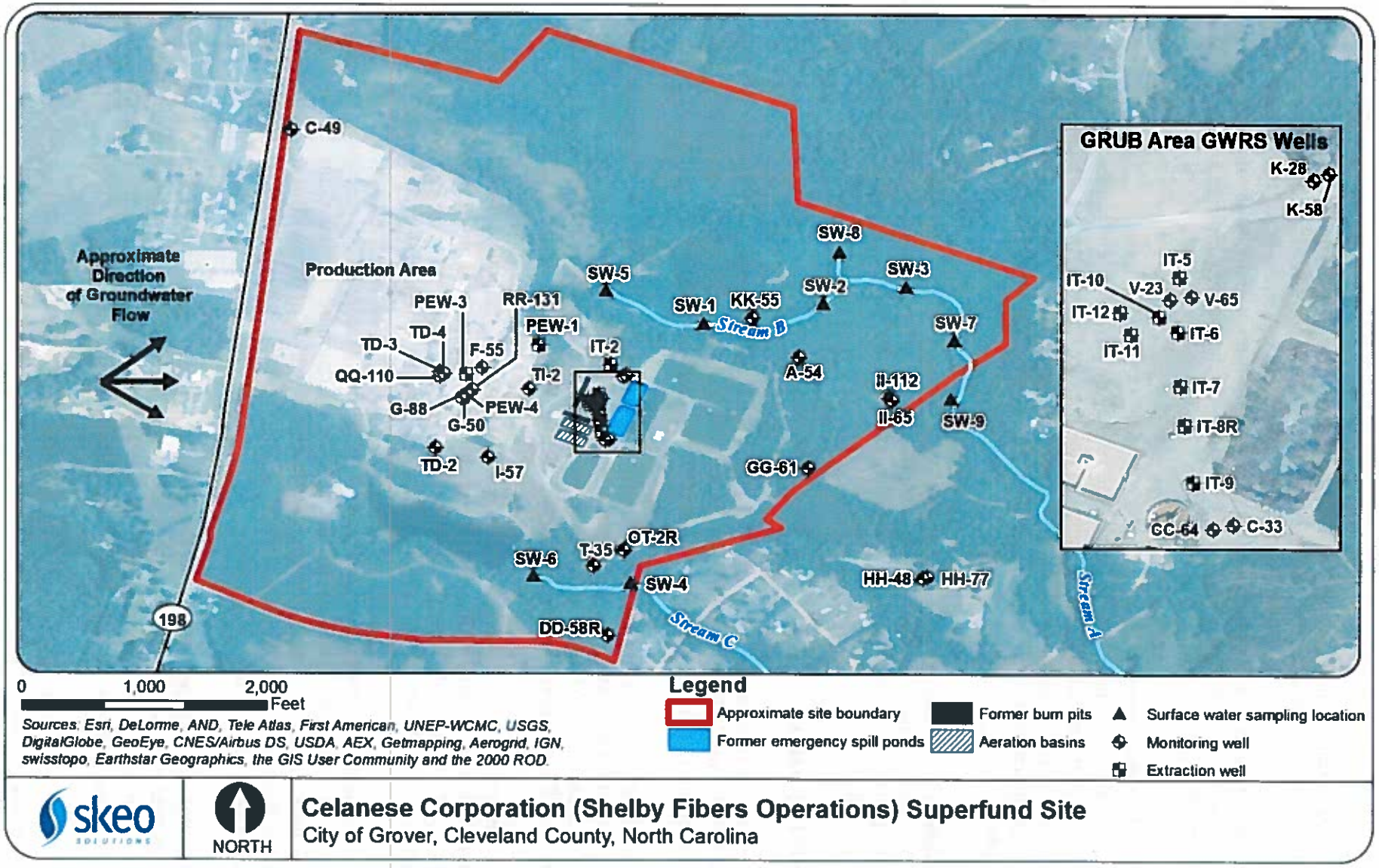
Ethylene Glycol

Historical and current groundwater monitoring data indicate the presence of two distinct areas impacted by EG – the area surrounding well F-55, east of the polymer production area, and immediately downgradient of the former GRUB waste disposal area (Figure 4). In general, since March 2011, EG concentrations tend to fluctuate sitewide, with recent (March 2015) decreasing concentrations observed at wells immediately downgradient of the extraction wells (IT-5, IT-7, IT-8R, IT-10, IT-12, K-28, V-23 and V-65) (Table I-5). These decreases suggest that the extraction system is effectively removing EG from site groundwater at the former GRUB area.

SVOCs at Well F-55

Between March 2011 and March 2015, concentrations of 1,1-biphenyl, naphthalene and phenol exceeded their respective North Carolina 2L standards only at well F-55 (Figure 4 and Table I-6). DOWTHERM™A is a heat transfer fluid comprised of about 73 percent diphenyl ether and 27 percent 1,1-biphenyl. This dense non-aqueous phase liquid (DNAPL) is routinely found in well F-55, as the use of the fluid in previous facility operations impacted the well. In general, since March 2011, 1,1-biphenyl, naphthalene and phenol concentrations tend to fluctuate at F-55, with no significant trends observed.

Figure 4: Groundwater and Surface Water Sampling Locations



Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding the EPA's response actions at the Site.

When detected during sampling events, AECOM measures the depth of the DNAPL in well F-55. Between June 2006 and March 2011, the thicknesses of DNAPL observed in well F-55 remained relatively stable. Since October 2011, the DNAPL thicknesses measured in well F-55 have shown an overall increase (Table I-7). This increase suggests that MNA and the operation of the GWRS may not be capable of addressing the source of DNAPL at well F-55. It also may indicate an ongoing source of DOWTHERM^{TM}A at or near well F-55.

Laboratory Detection Limits
Between 2011 and 2015, the detection limits used to analyze groundwater samples for benzene, 1,4-dioxane, EG, naphthalene and bis(2-ethylhexyl)phthalate were higher than the established cleanup goals in a few instances. It is not possible to accurately compare groundwater COC concentrations to cleanup goals if the analytical detection limits are unable to detect COC concentrations at cleanup goal concentrations.

Surface Water
Between March 2011 and March 2015, 1,4-dioxane was the only constituent detected in site surface water. During that same period, none of the results exceeded the NCAC 2B surface water standard of 0.08 mg/L (Table I-8).

6.5 Site Inspection

The site inspection took place on February 17, 2016. The inspection team included Ken Mallary (EPA Region 4 RPM), David Mattison (NCDEQ), Everett Glover (AECOM), PEM Carter, Steve Simpson and Michael Simpson (Celanese), and Melissa Oakley and Treat Suomi (Skeo Solutions).

The site inspection began with a safety and informational briefing. The site tour began east of the facility's production area, at the location of monitoring wells F-55 and PEW-3, and then proceeded west, to wells TD-3 and TD-4. All wells observed were secured, clearly labeled and appeared to be in good condition. DuraFiber operates in the buildings immediately west of wells TD-3 and TD-4.

Site inspection participants observed the former GRUB area. Vegetation at the former GRUB area is well established and appeared healthy. Participants then observed the three recently installed extraction wells (IT-10, IT-11 and IT-12) and the facility's WWTP. The WWTP was operational at the time of the site inspection. All WWTP system components appeared to be functioning as designed.

The inspection team observed the former location of the incinerator and the remains of the building previously used to stage and store materials during the operation of the incinerator. North of the former incinerator location, the site inspection team observed the section of Stream B where remediation took place, near surface water sampling point SW-5. The stormwater discharge point near SW-5 appeared to be in good condition and fully operational.

A tall fence with locking gates surrounds the 123-acre process area part of the Site and restricts access. The process area includes the on-site facility, the WWTP and GRUB area. Signage along the fence warns the public and deters trespassing. All site visitors must check in at the main gatehouse before entering the process area of the Site. Escorts accompany all site visitors.

On February 16, 2016, Skeo Solutions staff visited the Site's local information repository, the Cleveland County Memorial Library, located at 104 Howie Drive in Shelby, North Carolina. A records review

verified that a large collection of older printed site-related documents is available for public viewing, including the RODs, RI/FS, ESD, Remedial Design Reports, the 2001 FYR and EPA fact sheets. The 2006 and 2011 FYRs were not available.

Appendix D includes a completed Site Inspection Checklist. Appendix E includes photographs taken during the site inspection.

6.6 Interviews

The FYR process included interviews with parties affected by the Site, including the current landowners and regulatory agencies involved in site activities or aware of the Site. The purpose was to document the perceived status of the Site and any perceived problems or successes with the phases of the remedy implemented to date. The interviews are summarized below. Appendix C provides the complete interviews.

EPA RPM Ken Mallary stated that the project is progressing well and that the operation of the three new extraction wells has improved remedy performance. Celanese representatives are periodically in contact with nearby residents, and they seem to be satisfied with the cleanup. Mr. Mallary suggested that Celanese should continue to monitor the levels of VOCs in groundwater in the area behind the plant, determine if elevated VOCs are present in soil and groundwater beneath current production areas, and consider the need for collecting soil gas samples, if appropriate. He indicated that NCDEQ is working to finalize needed institutional controls for the site property.

NCDEQ site manager David Mattison has a positive impression of the project due to the resumption of groundwater extraction treatment activities and recent efforts made to characterize 1,4-dioxane at the Site. He is not aware of any changes to state laws that might affect the protectiveness of the Site's remedy. However, he indicated that some North Carolina groundwater standards have changed since the signing of the 1988 ROD and that these changes could potentially extend the timeframe for cleanup in the long term. While institutional controls are not yet in place for the site property, Mr. Mattison stated that efforts are currently underway to finalize and implement the needed land use restrictions. He suggested that the management and operation of the Site's remedy should continue to build upon the successes of the previous five years and continue to seek ways to optimize contaminant removal and treatment at the Site.

Everett Glover from PRP contractor AECOM indicated that the project is well managed and the remedy is functioning as designed. He stated that monitoring data show COC concentrations are decreasing through natural attenuation mechanisms or through groundwater removal and treatment at the former GRUB disposal area. Downgradient, COC concentrations in groundwater show some fluctuation and decrease with distance from the source area. Mr. Glover indicated that there is a continuous O&M presence at the Site and there have been no significant changes in O&M activities regarding the monitoring well network in the last five years. Operations monitoring began after installation of the three new extraction wells in 2012, resulting in increased inspection frequency for that part of the system. One of the groundwater extraction pumps failed shortly after installation and was replaced. Other than that, Mr. Glover indicated that there has been no other unusual maintenance required during the previous five years. He suggested that reducing groundwater monitoring frequency from semiannually to annually and reducing operational monitoring of extraction wells to semi-annually could reduce monitoring costs by about half.

PRP representatives PEM Carter and Steven Simpson have a positive impression of remedial activities at the Site. They indicated that operation of the GRUB area GWRS compliments MNA and may help shorten the duration of groundwater cleanup efforts. Ms. Carter and Mr. Simpson indicated that the Site has had a positive impact on the community through employment and community outreach efforts. They also stated that they have an effective working relationship with the EPA and NCDEQ.

7.0 Technical Assessment

7.1 Question A: Is the remedy functioning as intended by the decision documents?

The review of relevant documents, ARARs and risk assumptions and the site inspection indicate that the Site's remedy is not fully operating and functioning as designed by site decision documents. Groundwater is not used at or near the Site and the excavation of GRUB sludge, contaminated stream sediment, burn pit residuals, plastic chips and contaminated soil addressed the primary sources of site contamination. There are no complete exposure pathways at the Site. According to the OU1 ROD, the OU1 remedy should address residual contamination located below the excavation depth. While not specified as the selected groundwater remedy in the ROD, MNA and the operation of the GRUB area GWRS are currently being used to address groundwater contamination at the Site. However, groundwater monitoring data indicate that the operation of the GRUB area GWRS and MNA may not be capable of effectively removing all residual source contamination. These conditions indicate that additional remedial actions may be needed to reach sitewide groundwater cleanup goals.

Concentrations of site-related COCs in groundwater routinely exceed North Carolina groundwater standards. TCE concentrations at wells TD-3, TD-4 and QQ-110 consistently and significantly exceed the North Carolina 2L groundwater standard of 0.003 mg/L and the MCL of 0.005 mg/L. In general, since March 2011, TCE concentrations tend to fluctuate sitewide, with no significant trends observed. Groundwater monitoring results do not indicate that MNA is effectively addressing TCE concentrations at the TD well area. Between June 2006 and March 2015, the DNAPL thicknesses measured in well F-55 showed an overall increase. This increase suggests that MNA and the operation of the GWRS may not be capable of addressing the source of DNAPL at well F-55. Monitoring data indicate that concentrations of 1,4-dioxane above the 0.003 mg/L cleanup goal are common at most site monitoring wells. Detectable concentrations of 1,4-dioxane in surface water indicates that the constituent is being discharged from groundwater into site streams. However, between March 2011 and March 2015, concentrations of 1,4-dioxane in site surface water did not exceed the NCAC 2B surface water standard of 0.08 mg/L. With the possible exception of 1,4-dioxane, groundwater monitoring data suggest that groundwater COCs are not migrating off site. It is expected that the continued operation of the GRUB area GWRS will help address the source of 1,4-dioxane. However, given the prevalence of elevated 1,4-dioxane concentrations sitewide, additional actions may be needed to adequately address the contaminant in site groundwater.

Between 2011 and 2015, the laboratory detection limits used to analyze groundwater samples for benzene, 1,4-dioxane, EG, naphthalene and bis(2-ethylhexyl)phthalate were higher than the established cleanup goals in a few instances. It is not possible to accurately compare groundwater COC concentrations to cleanup goals if the analytical detection limits are unable to detect COC concentrations at cleanup goal concentrations.

While site decision documents do not require institutional controls, land and groundwater use restrictions are needed due to the presence of site-related contamination above concentrations that allow

for unrestricted use. Institutional controls – in the form of water supply agreements – are currently in place for residential properties downgradient from the facility property. Downgradient residents are connected to Cleveland County's municipal water supply and the water supply agreements prevent the installation of new wells in the future, as long as the municipal water supply is available. Groundwater is not in use on site or at the downgradient residential properties. Institutional controls are not in place for the site property to prevent future groundwater use, to prevent exposure to residual source area soil contamination or to prevent activities that could compromise the integrity of the selected remedy in the future. Celanese and NCDEQ have drafted a Declaration of Perpetual Land Use Restrictions to meet the need for site property institutional controls. The EPA has approved the Declaration. The document is awaiting final approval from the Assistant General Counsel for the NCDEQ. A tall fence and locking gates surround the main production facility part of the Site and security protocols ensure that unauthorized visitors do not have access to the property.

O&M activities at the Site consist of maintaining monitoring wells and the GWRS, and the maintenance of the IT groundwater treatment system in the event that the system needs to be put back into operation. Inspections are conducted on a regular basis. Any monitoring well maintenance or repairs are completed on an as-needed basis during semi-annual sampling events.

7.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels and remedial action objectives (RAOs) used at the time of remedy selection still valid?

The groundwater cleanup is still ongoing; contamination is still present at levels greater than cleanup goals. No one is currently using groundwater in the vicinity of the Site as a source of drinking water, so the groundwater does not pose a current risk through ingestion. Changes in groundwater ARARs since the OU1 ROD do not affect protectiveness since groundwater cleanup goals change as the North Carolina 2L groundwater standards change. Celanese compares groundwater monitoring data to current North Carolina 2L groundwater standards.

The presence of TCE concentrations well above the MCL in close proximity to the enclosed and occupied production facility may pose a vapor intrusion risk to people working in the building. To determine if current concentrations of VOCs detected in site groundwater remain protective of the vapor intrusion exposure pathway, this FYR evaluated maximum concentrations of VOCs identified in shallow wells near the enclosed production area building. Well TD-3 is the closest shallow well next to the production area building; it best represents the vapor source closest to the building foundation. EPA's 2015 Vapor Intrusion Screening Level (VISL) calculator demonstrates that the cumulative risks associated with chloroform and TCE detected in well TD-3 are within EPA's risk management range of 1×10^{-6} to 1×10^{-4}, as well as below the non-cancer hazard index (HI) of 1.0. Deep well F-55 contains DNAPL and elevated concentrations of VOCs and SVOCs. However, the well is located about 250 feet downgradient of the production area building. Based on the downgradient location and distance from the enclosed production area building, the VOCs and SVOCs present at well F-55 are not expected to contribute to the vapor intrusion exposure pathway at the production area. Appendix H includes additional vapor intrusion assessment information.

The Site's 1988 FS Report stated that remedial alternatives were developed to eliminate or reduce the primary source of contamination to minimize the spread of contaminants to groundwater and surface water. The removal and treatment of contaminated source materials effectively reduces the migration of site-related contaminants to groundwater and surface water pathways. Operation of the GRUB area GWRS helps address residual source area contamination that was not removed during the OU2 remedial

action. The combination of MNA and the operation of the GRUB area GWRS will continue to address residual contamination. However, based on groundwater monitoring data, additional remedial actions may be needed to reach sitewide groundwater cleanup goals.

7.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No new information has come to light that could call into question the protectiveness of the remedy.

7.4 Technical Assessment Summary

The review of relevant documents, ARARs and risk assumptions, and the site inspection indicate that the Site's remedy is not fully operating and functioning as designed by site decision documents. There are no complete exposure pathways at the Site and OU2 remedial actions have effectively reduced the migration of site-related contaminants to groundwater and surface water pathways. Groundwater institutional controls, in the form of water supply agreements, are currently in place for residential properties downgradient from the facility property. MNA and operation of the GRUB area GWRS help address residual source area contamination not removed during the OU2 remedial action. However, groundwater monitoring data indicate that the operation of the GRUB area GWRS and MNA may not be capable of effectively removing all residual source contamination. These conditions indicate that additional actions may be needed to reach sitewide groundwater cleanup goals. In addition, groundwater data indicate that the current extent of 1,4-dioxane contamination in site groundwater has not been fully defined. Institutional controls have not been finalized for the site property to prevent future groundwater use, prevent exposure to residual source area soil contamination or to prevent activities that could compromise the integrity of the selected remedy in the future.

8.0 Issues, Recommendations and Follow-up Actions

Table 6: Issues and Recommendations Identified in the Five-Year Review

OU(s): OU1 and OU2	Issue Category: Institutional Controls			
	Issue: Institutional controls were not called for in site decision documents. Due to the presence of site-related contamination above concentrations that allow for unrestricted use, land and groundwater use restrictions are needed for both the site facility property and downgradient properties. Institutional controls have not been implemented for the site facility property.			
	Recommendation: Finalize institutional controls for the site facility property to prevent future groundwater use. For areas of the site facility property where residual soil contamination remains, finalize institutional controls to prevent exposure to residual source area soil contamination and prevent activities that could compromise the integrity of the selected remedy in the future. Document the need for institutional controls in a decision document.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP and EPA	EPA	08/31/2018

OU(s): OU1	Issue Category: Remedy Performance			
	Issue: Groundwater monitoring data indicate that MNA and the operation of the GRUB area GWRS may not be capable of adequately addressing residual sources of groundwater contamination at the Site. Specifically, current groundwater remedial actions do not seem capable of effectively addressing TCE in the TD-well area, DNAPL and SVOCs at well F-55, and 1,4-dioxane in sitewide groundwater.			
	Recommendation: Perform an evaluation to determine if the GRUB area GWRS and MNA are capable of adequately addressing the sources of TCE in the TD-well area, DNAPL and SVOCs at well F-55, and 1,4-dioxane in sitewide groundwater. Also perform an investigation to determine the cause of the increase in DNAPL in well F-55. Based on evaluation findings, implement additional remedial actions as needed.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	08/31/2018

OU(s): OU1	Issue Category: Monitoring			
	Issue: Between 2011 and 2015, in a few instances, the laboratory detection limits used to analyze groundwater samples for benzene, 1,4-dioxane, ethylene glycol, naphthalene and bis(2-ethylhexyl)phthalate were higher than the established cleanup goals.			
	Recommendation: Review all detection limits currently used to analyze groundwater COC concentrations to ensure that all detection limits are as low as, or lower than, COC cleanup goals. Change analytical methods used to analyze groundwater if needed.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	8/31/2018

OU(s): OU1	Issue Category: Monitoring			
	Issue: The current extent of 1,4-dioxane contamination in site groundwater has not been fully defined.			
	Recommendation: Collect groundwater samples from points outside of the current monitoring well network to adequately determine the full extent of the 1,4-dioxane plume.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	8/31/2018

The following additional items, though not expected to affect protectiveness, warrant additional follow up:

- Since the previous FYR, monitoring wells T-1 and T-2 were accidentally destroyed during the demolition of the High Stack Warehouse, located between the main facility and North Carolina Highway 198. Those wells were located upgradient of the main process area and have not been sampled since the previous FYR. Properly abandon wells T-1 and T-2.
- Document whether analysis of metals in groundwater is required.
- Using current EPA vapor intrusion assessment guidance, consider performing a screening-level vapor intrusion assessment for wells HH-48 and HH-77, using the most recent groundwater data available.
- Provide copies of recent site-related documents to the Site's local information repository, including the 2006 and 2011 FYRs.

9.0 Protectiveness Statements

Table 7: Protectiveness Statements

Protectiveness Statement(s)		
Operable Unit: OU1	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):* Click here to enter date.
Protectiveness Statement: The selected remedy for OU1 currently protects human health and the environment because exposure pathways that could result in unacceptable risks have been addressed. No one uses groundwater for drinking at or downgradient from the Site and institutional controls are in place at the downgradient residential properties to prevent installation of new groundwater wells. MNA and the operation of the GRUB area GWRS are currently being used to address groundwater contamination at the Site. However, in order for the remedy to be protective in the long term the following actions are needed: finalize institutional controls to prevent future groundwater use at the site property; collect groundwater samples from points outside of the current monitoring well network to adequately determine the full extent of the 1,4-dioxane plume; ensure all detection limits currently used to analyze groundwater COC concentrations are as low as, or lower than, all COC cleanup goals and change analytical methods used to analyze groundwater if needed. In addition, evaluations are needed to determine the cause of the increase in DNAPL in well F-55 and to determine if the GRUB area GWRS and MNA are capable of adequately addressing the sources of TCE in the TD-well area, DNAPL and SVOCs at well F-55, and 1,4-dioxane in sitewide groundwater. Based on evaluation findings, implementation of additional remedial actions may be needed.		

Operable Unit: OU2	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):* Click here to enter date.
Protectiveness Statement: The selected remedy for OU2 currently protects human health and the environment because exposure pathways that could result in unacceptable risks have been addressed. OU2 remedial actions removed the primary sources of site contamination and have effectively reduced the		

migration of site-related contaminants to groundwater and surface water pathways. For the remedy to be protective over the long term, for areas of the site facility property where residual soil contamination remains, finalize institutional controls to prevent exposure to residual source area soil contamination and prevent activities that could compromise the integrity of the selected remedy in the future. Documentation of the need for institutional controls in a decision document is also needed.

Sitewide Protectiveness Statement	
Protectiveness Determination: Short-term Protective	*Addendum Due Date (if applicable):* Click here to enter date.
Protectiveness Statement: Because the remedies for OU1 and OU2 are protective in the short term, the sitewide remedy is currently protective. For the remedy to be protective over the long term, the issues identified for OU1 and OU2 need to be addressed.	

10.0 Next Review

The next FYR will be due within five years of the signature/approval date of this FYR.

Appendix A: List of Documents Reviewed

EPA Explanation of Significant Differences, Celanese Fiber Operations, Shelby, North Carolina. April 23, 2004.

EPA Record of Decision for Operable Unit 1, Celanese Fibers Operations, Shelby, North Carolina. March 23, 1988.

EPA Record of Decision for Operable Unit 2, Celanese Fibers Operations, Shelby, North Carolina. March 28, 1989.

Fifth Five-Year Review Report for Celanese Corporation (Shelby Fiber Operations), Grover, Cleveland County, North Carolina. August 31, 2011.

Final Remedial Investigation Report, Celanese Fibers Operations, Shelby, North Carolina. Prepared by S&ME, Inc. for EPA Region 4. June 1987.

Final Feasibility Study Report, Operable Unit 2 – Source Material, Hoechst Celanese Facility, Shelby, North Carolina. Prepared by S&ME, Inc. for EPA Region 4. January 27, 1989.

Final Feasibility Study Report, Operable Unit 2 – Groundwater Public Health Assessment for Celanese Fibers Operations, Shelby, North Carolina. Prepared by S&ME, Inc. for EPA Region 4. February 26, 1988.

Five Year Review Report, Operable Unit 2, Celanese Shelby Fibers Superfund Site, Shelby, Cleveland County, North Carolina. December 1995.

Limited Vapor Intrusion Assessment for the Celanese Five Year Review – Memorandum on Vapor Intrusion for Monitoring Well HH-48. EPA Region 4. May 20, 2011.

OU1 Semiannual Report, First Half 2015, Celanese Fibers Operations Site, Shelby, North Carolina. Prepared by AECOM for CAN Holdings LLC. September 2015.

OU1 Semiannual Report, Second Half 2014, Celanese Fibers Operations Site, Shelby, North Carolina. Prepared by AECOM for CAN Holdings LLC. March 2015.

OU1 Semiannual Report, First Half 2014, Celanese Fibers Operations Site, Shelby, North Carolina. Prepared by AECOM for CAN Holdings LLC. August 2014.

OU1 Semiannual Report, Second Half 2013, Celanese Fibers Operations Site, Shelby, North Carolina. Prepared by AECOM for CNA Holdings LLC. March 2014.

OU1 Semiannual Report, First Half 2013, Celanese Fibers Operations Site, Shelby, North Carolina. Prepared by AECOM for CNA Holdings LLC. September 2013.

OU1 Semiannual Report, Second Half 2012, Celanese Fibers Operations Site, Shelby, North Carolina. Prepared by AECOM for CNA Holdings LLC. March 2013.

OU1 Semiannual Report, First Half 2012, Celanese Fibers Operations Site, Shelby, North Carolina. Prepared by AECOM for CNA Holdings LLC. September 2012.

OU1 Semiannual Report, Second Half 2011, Celanese Fibers Operations Site, Shelby, North Carolina. Prepared by AECOM for CNA Holdings LLC. March 2012.

OU1 Semiannual Report, First Half 2011, Celanese Fibers Operations Site, Shelby, North Carolina. Prepared by AECOM for CNA Holdings LLC. September 2011.

Remedial Action Report, Operable Unit 1, Celanese Shelby Fiber Operations Superfund Site. Prepared by RUST Environment & Infrastructure for EPA Region 4. June 24, 1993.

Remedial Action Report, Operable Unit 2, Celanese Shelby Fiber Operations Superfund Site. Prepared by SEC Donohue Environment & Infrastructure for EPA Region 4. June 30, 1993.

Superfund Preliminary Close-Out Report, Celanese Shelby Fibers Operations, Shelby, Cleveland County, North Carolina. EPA Region 4. March 25, 1993.

Appendix B: Press Notice

The U.S. Environmental Protection Agency, Region 4 Announces the Sixth Five-Year Review for the Celanese Corp. (Shelby Fibers Operations) Superfund Site, Shelby, Cleveland County, North Carolina

Purpose/Objective: EPA is conducting a Five-Year Review of the remedy for the Celanese Corp. (Shelby Fibers Operations) Superfund site (the Site) in Shelby, North Carolina. The purpose of the Five-Year Review is to make sure the selected cleanup actions effectively protect human health and the environment.

Site Background: Since 1960, an active manufacturing facility has operated at the 450-acre site. The facility is now owned and operated by Ticona, a subsidiary of Celanese Corporation (Celanese). The Celanese plant originally produced filament thread and polyester staples for apparel and bedding products. In the 1960s, facility activities included discharging chemical wastes into an on-site ditch and burning and burying facility wastes on site. Between 1970 and 1979, Celanese stored drums of waste chemicals and solvents on a 3-acre portion of the site. Celanese began performing site investigations in 1981. These investigations determined that facility operations and waste disposal activities at the Site contaminated groundwater, soil and sediment. Contaminants of concern include heavy metals, polycyclic aromatic hydrocarbons (PAHs), inorganic chemicals and volatile organic compounds (VOCs). EPA listed the Site on the Superfund program's National Priorities List (NPL) in 1986.

Cleanup Actions: EPA divided the site into two areas, or operable units (OUs), to manage the long-term cleanup: OU1 (groundwater) and OU2 (soil and sediment). EPA selected the OU1 remedy in the Site's 1988 Record of Decision (ROD). The groundwater remedy included extraction and treatment of contaminated groundwater. Groundwater treatment began in 1989 and finished in 2004. In April 2004, EPA issued an Explanation of Significant Differences (ESD), changing the OU1 remedy to a two-year trial period for monitored natural attenuation (MNA). EPA extended the MNA study period in 2006. In 2010, Celanese – the Site's potentially responsible party (PRP) – identified localized areas of groundwater contamination. In 2012, the PRP began focused groundwater extraction and treatment to address those localized areas. Groundwater treatment and monitoring are ongoing.

EPA selected the OU2 remedy to address soil and sediment contamination in the Site's 1989 ROD. The final OU2 remedy included excavation and on-site incineration of contaminated sludge, sediment, soil, burn pit residuals and waste plastic chips. Cleanup also included the on-site stabilization of incinerated wastes, backfilling of excavated areas with the stabilized materials, and regrading and seeding of the areas with grass. The PRP performed OU2 remedial actions between 1991 and 1992. EPA took part of the Site off the NPL in 1998.

Five-Year Review Schedule: The National Contingency Plan requires review of remedial actions that result in any hazardous substances, pollutants or contaminants remaining at the Site above levels that allow for unlimited use and unrestricted exposure every five years to ensure the protection of human health and the environment. The sixth Five-Year Review for the Site will be completed by August 2016.

EPA Invites Community Participation in the Five-Year Review Process: EPA is conducting this Five-Year Review to evaluate the effectiveness of the Site's remedy and to ensure that the remedy remains protective of human health and the environment. As part of the Five-Year Review process, EPA staff is available to answer any questions about the Site. Community members who have questions about the Site or the Five-Year Review process, or who would like to participate in a community interview, are asked to contact:

Ken Mallary, EPA Remedial Project Manager
Phone: (404) 562-8802
Email: mallary.ken@epa.gov

Stephanie Brown, EPA Community Involvement Coordinator
Phone: (404) 562-8450 | (877) 718-3752 (toll-free)
Email: brown.stephaniey@epa.gov

Mailing Address: U.S. EPA Region 4, 61 Forsyth Street, S.W., 11th Floor, Atlanta, GA 30303-8960

Additional site information is available at the Site's local document repository, located at the Cleveland County Memorial Library, 104 Howie Drive, Shelby, North Carolina 28150, and online at:
http://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0402687.

Appendix C: Interview Forms

Celanese Corporation (Shelby Fibers Operations) Superfund Site — **Five-Year Review Interview Form**

Site Name: Celanese Corporation (Shelby Fibers Operations) **EPA ID No.:** NCD003446721

Interviewer Name: _____ **Affiliation:** _____

Subject Name: Ken Mallary **Affiliation:** EPA Region 4

Subject Contact Information: Work phone: (404) 562-8802
Email: mallary.ken@epa.gov

Time: _____ **Date:** 03/02/2016

Interview Location: _____

Interview Format (circle one): In Person Phone Mail Other: Email

Interview Category: EPA Remedial Project Manager

1. What is your overall impression of the project, including cleanup, maintenance and reuse activities (as appropriate)?

   This is the sixth FYR for the Site. The overall cleanup process has been going well. OU1 has been in the O&M phase for many years. OU2 was completed over 20 years ago.

2. What have been the effects of the Site on the surrounding community, if any?

   Celanese provided the residents in a nearby neighborhood with county water years ago and paid for their water bills for a period. Celanese representatives are periodically in contact with the nearby residents, and the residents seem to be satisfied with the cleanup. I am not aware of any other effects on the local community.

3. Are you aware of any complaints or inquiries regarding site-related environmental issues or remedial activities since the implementation of the cleanup?

   I am not aware of any complaints by local officials or residents regarding the cleanup.

4. What is your assessment of the current performance of the remedy in place at the Site?

   Continued monitoring of COCs is ongoing. The performance of OU1 has improved since the three new extraction wells have been in operation.

5. Are you comfortable with the status of the institutional controls at the Site? If not, what are the associated outstanding issues?

   Institutional controls are ready to be placed on the property deed at the Site. NCDEQ is prepared to get the institutional controls in place during this FYR.

6. Are you aware of any community concerns regarding the Site or the operation and management of its remedy? If so, please provide details.

None.

7. Do you have any comments, suggestions or recommendations regarding the management or operation of the Site's remedy?

   Celanese should continue to monitor the levels of VOCs in groundwater in the area behind the plant, determine if elevated VOCs are present in soil and groundwater beneath current production areas, and consider the need for collecting soil gas samples if appropriate.

Site Name: Celanese Corporation (Shelby Fibers Operations) **EPA ID No.:** NCD003446721

Interviewer Name: _____ **Affiliation:** _____

Subject Name: David Mattison **Affiliation:** NCDEQ

Subject Contact Information: T: (919) 707-8336
Address: 217 W. Jones Street, 1646 Mail Service Center, Raleigh, NC 27699-1646

Time: _____ **Date:** 02/29/2016

Interview Location: _____

Interview Format (circle one): In Person Phone Mail Other: Email

Interview Category: State Agency

1. What is your overall impression of the project, including cleanup, maintenance and reuse activities (as appropriate)?

   Overall impression of the project is good due to significant achievements in the previous five years (resumption of groundwater extraction and treatment activities, site characterization of 1,4-dioxane contamination).

2. What is your assessment of the current performance of the remedy in place at the Site?

   Assessment of the current performance of the remedy in place at the Site is good, as extraction and treatment continues. Remediation will continue, as will efforts to ensure complete capture of the contaminant plume and facilitate site closure as soon as technically feasible.

3. Are you aware of any complaints or inquiries regarding site-related environmental issues or remedial activities from residents in the past five years?

   No.

4. Has your office conducted any site-related activities or communications in the past five years? If so, please describe the purpose and results of these activities.

   No.

5. Are you aware of any changes to state laws that might affect the protectiveness of the Site's remedy?

   No. Although some North Carolina groundwater standards have changed since the signing of the 1988 ROD for OU1, this does not affect protectiveness in the short term as groundwater extraction and treatment continue. It may potentially extend the timeframe for cleanup over the long term.

6. Are you comfortable with the status of the institutional controls at the Site? If not, what are the associated outstanding issues?

   No. However, although institutional controls have not been implemented for the Site, efforts are currently underway to address this recommendation.

7. Are you aware of any changes in projected land use(s) at the Site?

   No.

8. Do you have any comments, suggestions or recommendations regarding the management or operation of the Site's remedy?

   The management/operation of the Site's remedy should continue to build upon the successes of the previous five years and continue to seek efficiencies in contaminant removal and treatment at the Site.

Site Name: Celanese Corporation (Shelby Fibers Operations) **EPA ID No.:** NCD003446721
Interviewer Name: _____ **Affiliation:** _____
Subject Name: Everett Glover **Affiliation:** AECOM
Subject Contact Information: everett.glover@aecom.com
Time: _____ **Date:** 03/02/2016
Interview Location: _____
Interview Format (circle one): In Person Phone Mail Other: Email
Interview Category: O&M Contractor

1. What is your overall impression of the project, including cleanup, maintenance and reuse activities (as appropriate)?

   The project is well-managed and well-funded to achieve the long-term goal of protection.

2. What is your assessment of the current performance of the remedy in place at the Site?

   The remedy is functioning as designed and the monitoring program is adequate to monitor the conditions at the former source areas and downgradient.

3. What are the findings from the monitoring data? What are the key trends in contaminant levels that are being documented over time at the Site?

   The source area concentrations are declining through natural attenuation mechanisms or through groundwater removal and treatment from the Former GRUB Disposal Area. Downgradient, the constituent levels fluctuate some and decline with distance from the source toward local discharge areas or in areas of administrative control. This information is documented in the semiannual monitoring reports currently submitted in March and September annually.

4. Is there a continuous on-site O&M presence? If so, please describe staff responsibilities and activities. Alternatively, please describe staff responsibilities and the frequency of site inspections and activities if there is not a continuous on-site O&M presence.

   The Ticona Plant has continuous maintenance for the general facility for maintaining lawn cutting, etc., inside the plant's security fencing around the overall plant operations area. The wastewater treatment plant area, IT wells, perimeter security fencing, and OT extraction area are inspected daily during non-holiday weekdays. Furthermore, on the weekends and holidays, general operational checks are made in the wastewater treatment plant and IT well area. The monitoring well network is inspected at least semi-annually during the routine sampling events. The extraction wells have been inspected approximately monthly for ongoing operations monitoring.

5. Have there been any significant changes in site O&M requirements, maintenance schedules or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.
   There have been no significant changes in O&M activities for the monitoring well network in the last five years. However, operations monitoring began after installation of the extraction wells in 2012 and this resulted in increased inspection frequency in this part of the system. Neither the

protectiveness nor effectiveness of the remedy has been negatively affected during the last five years.

6. Have there been unexpected O&M difficulties or costs at the Site since start-up or in the last five years? If so, please provide details.

   There have been no unexpected O&M difficulties or costs. One of the groundwater extraction pumps failed shortly after installation and was replaced. No other unusual maintenance has been required.

7. Have there been opportunities to optimize O&M activities or sampling efforts? Please describe changes and any resulting or desired cost savings or improved efficiencies.

   The past five years of information has provided a good baseline of information about site conditions and operational stability of the extraction system. No opportunities have been taken to optimize the activities.

8. Do you have any comments, suggestions or recommendations regarding O&M activities and schedules at the Site?

   The current monitoring program provides reasonable spatial representation of site conditions and have documented that the locations and concentrations are generally stable to declining and are not changing quickly. In the future, a similar level of confidence in the information could be obtained by reducing the monitoring frequency from semiannual to annual and reducing the operational monitoring on the extraction wells to semiannual until a time where the data begin to change more quickly or until a time when the concentrations approach site closure levels. This would reduce the monitoring cost by approximately 50 percent.

Site Name: Celanese Corporation (Shelby Fibers Operations) **EPA ID No.:** NCD003446721

Interviewer Name: _____ **Affiliation:** _____

Subject Name: Steven Simpson and PEM Carter **Affiliation:** Celanese

Subject Contact Information: steven.simpson_contractor@celanese.com and PEM.carter@celanese.com

Time: _____ **Date:** 02/20/2016

Interview Location: _____

Interview Format (circle one): In Person Phone Mail Other: Email

Interview Category: Potentially Responsible Party (PRP)

1. What is your overall impression of the remedial activities at the Site?

   The Shelby site remediation is very mature. Sources have been removed, ongoing releases eliminated. Groundwater impacts at former source area (GRUB pits) are mitigated through ongoing pump and treat.

2. What have been the effects of the Site on the surrounding community, if any?

   Since startup in the early 1960s, the Shelby plant has had a very positive impact on the community through continuous employment and community outreach.

3. What is your assessment of the current performance of the remedy in place at the Site?

   MNA is the appropriate long-term solution for the groundwater impacts. The timeline of MNA can be shortened by effective treatment (P&T) at former source area (GRUB pits).

4. Are you aware of any complaints or inquiries regarding environmental issues or the remedial action from residents since implementation of the cleanup?

   Discussions and inquires – yes. Celanese has maintained a community advisory panel over the years that has been a forum for discussing environmental projects and general plant initiatives. In addition, several neighbor meetings were held during the periods that county water and a property price protection programs were offered to downgradient neighbors.

5. Do you feel well-informed regarding the Site's activities and remedial progress?

   Yes. If not, how might EPA convey site-related information in the future? Response: There is an effective and open working relationship with both DEQ and the EPA.

6. Do you have any comments, suggestions or recommendations regarding the management or operation of the Site's remedy?

   No.

Appendix D: Site Inspection Checklist

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST

I. SITE INFORMATION

Site Name: Celanese Corporation (Shelby Fibers Operations)	**Date of Inspection:** 02/17/2016
Location and Region: Grover, Cleveland County, NC/EPA Region 4	**EPA ID:** NCD003446721
Agency, Office or Company Leading the Five-Year Review: EPA Region 4	**Weather/Temperature:** Sunny and 50 degrees F.

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☐ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other: _____
- ☒ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (check all that apply)

1. **O&M Site Manager** — Everett Glover (Name); Senior Program Director, Environment, AECOM (Title); 03/02/2016 (Date)
   Interviewed ☐ at site ☐ at office ☒ by email Phone: 678-808-8960
   Problems, suggestions ☐ Report attached: Interview responses are summarized in Section 6.6.

2. **O&M Staff** — _____ (Name); _____ (Title); _____ (Date)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone: _____
   Problems/suggestions ☐ Report attached: _____

3. **Local Regulatory Authorities and Response Agencies** (i.e., state and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices). Fill in all that apply.

   Agency NCDEQ
   Contact David Mattison (Name) | NCDEQ Site Manager (Title) | 02/29/2016 (Date) | 919-707-8336 (Phone No.)
   Problems/suggestions ☐ Report attached: Interview responses are summarized in Section 6.6.

   Agency _____
   Contact _____ (Name) | _____ (Title) | _____ (Date) | _____ (Phone No.)
   Problems/suggestions ☐ Report attached: _____

   Agency _____
   Contact _____ (Name) | _____ (Title) | _____ (Date) | _____ (Phone No.)
   Problems/suggestions ☐ Report attached: _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone No.
Problems/suggestions ☐ Report attached: _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone No.
Problems/suggestions ☐ Report attached: _____

4. **Other Interviews** (optional) ☒ Report attached: Interview responses are summarized in Section 6.6.

EPA Site RPM Ken Mallary

PEM Carter and Steven Simpson, Ticona/Celanese

III. ON-SITE DOCUMENTS AND RECORDS VERIFIED (check all that apply)

1. **O&M Documents**

☒ O&M manual	☒ Readily available	☒ Up to date	☐ N/A
☒ As-built drawings	☒ Readily available	☒ Up to date	☐ N/A
☒ Maintenance logs	☒ Readily available	☒ Up to date	☐ N/A

Remarks: _____

2. **Site-Specific Health and Safety Plan** ☒ Readily available ☒ Up to date ☐ N/A

☒ Contingency plan/emergency response plan ☒ Readily available ☒ Up to date ☐ N/A

Remarks: Celanese maintains the Site's health and safety plan and emergency response plan on site.

3. **O&M and OSHA Training Records** ☒ Readily available ☒ Up to date ☐ N/A

Remarks: Celanese maintains all training records for staff in hard copies on site and electronically. Seventy-three Celanese staff are currently certified in first aid, CPR and automated external defibrillator use. Other Celanese emergency responders include a hazardous materials response team, an emergency medical technician and confined space rescuers.

4. **Permits and Service Agreements**

☒ Air discharge permit	☒ Readily available	☒ Up to date	☐ N/A
☒ Effluent discharge	☒ Readily available	☒ Up to date	☐ N/A
☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
☒ Other permits: Stormwater and land application permits.	☒ Readily available	☒ Up to date	☐ N/A

Remarks: Celanese operates under the following permits: NPDES, stormwater, land application and air. Only the NPDES permit relates to the site remedy. The other permits are required for facility operations.

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☒ N/A

Remarks: _____

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date ☒ N/A

Remarks: _____

7. **Groundwater Monitoring Records** ☒ Readily available ☒ Up to date ☐ N/A

Remarks: Celanese performs semi-annual groundwater monitoring and submits results to the EPA routinely, as required. Groundwater monitoring results are available.

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date ☒ N/A

Remarks: _____

9. **Discharge Compliance Records**

☒ Air ☒ Readily available ☒ Up to date ☐ N/A

☒ Water (effluent) ☒ Readily available ☒ Up to date ☐ N/A

Remarks: _____

10. **Daily Access/Security Logs** ☒ Readily available ☒ Up to date ☐ N/A

Remarks: All site visitors are required to sign in at the main facility entrance. The facility maintains copies of all daily access/sign-in documentation.

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for state

☐ PRP in-house ☒ Contractor for PRP

☐ Federal facility in-house ☐ Contractor for Federal facility

☒ PRP contractor AECOM performs semi-annual groundwater monitoring and routine inspections of remedial components.

2. **O&M Cost Records**

☒ Readily available ☒ Up to date

☐ Funding mechanism/agreement in place ☐ Unavailable

Original O&M cost estimate: The 1988 ROD for OU1 estimated that O&M costs to operate the groundwater treatment system would be about $1,100,000 for a 30-year period, or about $37,000 annually. Because the original groundwater treatment system in no longer in operation, and MNA, the new groundwater extraction system and long-term monitoring are currently being used to address groundwater contamination at the Site, a direct comparison of actual O&M costs and estimated costs is not appropriate.

Total annual cost by year for review period if available

Year: 2011	$327,000 Total cost	☐ Breakdown attached
Year: 2012	$520,000 Total cost	☐ Breakdown attached
Year: 2013	$238,000 Total cost	☐ Breakdown attached
Year: 2014	$140,000 Total cost	☐ Breakdown attached

Year: 2015 $215,000 ☐ Breakdown attached
Total cost

3. **Unanticipated or Unusually High O&M Costs during Review Period**

Describe costs and reasons: 2011 FYR support costs resulted in higher than average O&M costs in 2011. TD-area well installation and installation of the GRUB area groundwater extraction system resulted in atypically high O&M costs in 2012. 2013 O&M costs include extensive system monitoring performed at the startup of the extraction system. Costs in 2014 and 2015 are more representative of current, typical annual O&M costs.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing Damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A

Remarks: The 123-acre process area includes the on-site facility, WWTP and remedial components. A tall fence with locking gates surrounds the entire process area. The fence appeared to be in good condition.

B. Other Access Restrictions

1. **Signs and Other Security Measures** ☐ Location shown on site map ☐ N/A

Remarks: Fencing and strict security measures (required sign-in procedures, locked gates and required escorts for all visitors) restrict and closely monitor site access. Signs posted along the facility fence deter trespassing.

C. Institutional Controls (ICs)

1. **Implementation and Enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☒ N/A

Type of monitoring (e.g., self-reporting, drive by): _____

Frequency: _____

Responsible party/agency: _____

Contact _____ _____ _____ _____

Name Title Date Phone no.

Reporting is up to date ☐ Yes ☐ No ☒ N/A

Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☒ N/A

Violations have been reported ☐ Yes ☐ No ☒ N/A

Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☐ ICs are adequate ☒ ICs are inadequate ☐ N/A

Remarks: The ROD does not require institutional controls. However, due to the presence of contamination at the Site that does not allow for unrestricted land use, institutional controls are needed. Institutional controls to prevent groundwater use and the installation of private wells are in place for the residential area located downgradient of the Site. Land and groundwater use restrictions are not in place for the site property. Draft institutional controls are currently under review by the Assistant General Counsel of the

NCDEQ. See Section 6.3 for additional institutional control information.

D. General

1. **Vandalism/Trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks: There have been no instances of trespassing or vandalism within the fenced site process area. Since the previous FYR, trespassing took place at the Buffalo Creek NPDES discharge point and the recreational building near the fire pond. No trespassing signs are posted around the site perimeter.

2. **Land Use Changes On Site** ☐ N/A

Remarks: There have been no land use changes on site since the previous FYR. There are no plans for future land use changes on site.

3. **Land Use Changes Off Site** ☐ N/A

Remarks: There have been no land use changes surrounding the Site since the previous FYR. There are no plans for future land use changes surrounding the Site.

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads Damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks: Site roads are in good condition.

B. Other Site Conditions

Remarks: Since the previous FYR, a large structure, referred to as the High Stack Warehouse, has been demolished. The concrete building pad remains in place, located between the main site facility and North Carolina Highway 198.

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (low spots) ☐ Location shown on site map ☒ Settlement not evident

Arial extent: _____ Depth: _____

Remarks: Remedial actions included the burial of incinerated and stabilized soil, sludge and wastes in the former GRUB area. The PRP backfilled, graded and seeded the area following placement of the stabilized materials. The area is currently covered with well-established grass.

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident

Lengths: _____ Widths: _____ Depths: _____

Remarks: _____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident

Arial extent: _____ Depth: _____

Remarks: _____

4. **Holes** ☐ Location shown on site map ☒ Holes not evident

Arial extent: _____ Depth: _____

Remarks: _____

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established

☒ No signs of stress ☐ Trees/shrubs (indicate size and locations on a diagram)

Remarks: The grass covering the former GRUB area is well-established and appears healthy.

6. **Alternative Cover** (e.g., armored rock, concrete) ☒ N/A

Remarks: _____

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident

Arial extent: _____ Height: _____

Remarks: _____

8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident

☐ Wet areas	☐ Location shown on site map	Arial extent: _____
☐ Ponding	☐ Location shown on site map	Arial extent: _____
☐ Seeps	☐ Location shown on site map	Arial extent: _____
☐ Soft subgrade	☐ Location shown on site map	Arial extent: _____

Remarks: Not applicable.

9. **Slope Instability** ☐ Slides ☐ Location shown on site map

☒ No evidence of slope instability

Arial extent: _____

Remarks: Not applicable.

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay

Remarks: _____

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay

Remarks: _____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay

Remarks: _____

C. Letdown Channels ☐ Applicable ☒ N/A

(Channel lined with erosion control mats, riprap, grout bags or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ No evidence of settlement

Arial extent: _____ Depth: _____

Remarks: _____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation

Material type: _____ Arial extent: _____

Remarks: _____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion

Arial extent: _____ Depth: _____

Remarks: _____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting

Arial extent: _____ Depth: _____

Remarks: _____

5. **Obstructions** Type: _____ ☐ No obstructions

☐ Location shown on site map Arial extent: _____

Size: _____

Remarks: _____

6. **Excessive Vegetative Growth** Type: _____

☐ No evidence of excessive growth

☐ Vegetation in channels does not obstruct flow

☐ Location shown on site map Arial extent: _____

Remarks: _____

D. Cover Penetrations ☐ Applicable ☒ N/A

1. **Gas Vents** ☐ Active ☐ Passive

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A

Remarks: _____

2. **Gas Monitoring Probes**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A

Remarks: _____

3. **Monitoring Wells** (within surface area of landfill)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A

Remarks: _____

4. **Extraction Wells Leachate**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A

Remarks: _____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A

Remarks: _____

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**

   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse

   ☐ Good condition ☐ Needs maintenance

   Remarks: _____

2. **Gas Collection Wells, Manifolds and Piping**

   ☐ Good condition ☐ Needs maintenance

   Remarks: _____

3. **Gas Monitoring Facilities** (e.g., gas monitoring of adjacent homes or buildings)

   ☐ Good condition ☐ Needs maintenance ☐ N/A

   Remarks: _____

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A

   Remarks: _____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A

   Remarks: _____

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

1. **Siltation** Area extent: _____ Depth: _____ ☐ N/A

   ☐ Siltation not evident

   Remarks: _____

2. **Erosion** Area extent: _____ Depth: _____

   ☐ Erosion not evident

   Remarks: _____

3. **Outlet Works** ☐ Functioning ☐ N/A

   Remarks: _____

4. **Dam** ☐ Functioning ☐ N/A

   Remarks: _____

H. Retaining Walls ☐ Applicable ☒ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident

   Horizontal displacement: _____ Vertical displacement: _____

   Rotational displacement: _____

   Remarks: _____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident

   Remarks: _____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☒ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
   Area extent: _____ Depth: _____
   Remarks: _____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
   ☐ Vegetation does not impede flow
   Area extent: _____ Type: _____
   Remarks: _____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Area extent: _____ Depth: _____
   Remarks: _____

4. **Discharge Structure** ☐ Functioning ☐ N/A
   Remarks: _____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
   Area extent: _____ Depth: _____
   Remarks: _____

2. **Performance Monitoring** Type of monitoring: _____
   ☐ Performance not monitored
   Frequency: _____ ☐ Evidence of breaching
   Head differential: _____
   Remarks: _____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing and Electrical**
   ☒ Good condition ☒ All required wells properly operating ☐ Needs maintenance ☐ N/A
   Remarks: The three extraction wells located east of the former GRUB area were operational at the time of the site inspection.

2. **Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances**
   ☐ Good condition ☐ Needs maintenance
   Remarks: Extraction system pipelines, valve boxes and other appurtenances were not visible.

3. **Spare Parts and Equipment**
   ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
   Remarks: Not applicable.

B. Surface Water Collection Structures, Pumps and Pipelines ☒ Applicable ☐ N/A

1. **Collection Structures, Pumps and Electrical**

☒ Good condition ☐ Needs maintenance

Remarks: Site inspection participants observed a stormwater discharge structure near surface water sampling point SW-5, along Stream B. The structure appeared to be in good condition and was free of debris.

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes and Other Appurtenances**

☐ Good condition ☐ Needs maintenance

Remarks: Not applicable.

3. **Spare Parts and Equipment**

☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: Not applicable.

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (check components that apply)

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation

☐ Air stripping ☐ Carbon adsorbers

☐ Filters: _____

☐ Additive (e.g., chelation agent, flocculent): _____

☒ Others: Extracted groundwater is treated by the facilty's WWTP and discharged to Buffalo Creek.

☒ Good condition ☐ Needs maintenance

☐ Sampling ports properly marked and functional

☐ Sampling/maintenance log displayed and up to date

☐ Equipment properly identified

☐ Quantity of groundwater treated annually: _____

☐ Quantity of surface water treated annually: _____

Remarks: The WWTP was in full operation at the time of the inspection.

2. **Electrical Enclosures and Panels** (properly rated and functional)

☒ N/A ☐ Good condition ☐ Needs maintenance

Remarks: _____

3. **Tanks, Vaults, Storage Vessels**

☒ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs maintenance

Remarks: _____

4. **Discharge Structure and Appurtenances**

☐ N/A ☐ Good condition ☐ Needs maintenance

Remarks: The discharge location of treated groundwater and facility wastewater is located about two miles from the Site and was not observed during the inspection.

5. **Treatment Building(s)**

☒ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair

☐ Chemicals and equipment properly stored

Remarks: _____

6. **Monitoring Wells** (pump and treatment remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ All required wells located ☐ Needs maintenance ☒ N/A

Remarks: _____

D. Monitoring Data

1. **Monitoring Data**

☒ Is routinely submitted on time ☒ Is of acceptable quality

2. **Monitoring Data Suggests:**

☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

E. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition

☐ All required wells located ☐ Needs maintenance ☐ N/A

Remarks: Monitoring wells T-1 and T-2 were accidentally destroyed during the demolition of the High Stack Warehouse, located between the main facility and North Carolina Highway 198. Those wells were located upgradient of the main process area and have not been sampled since the previous FYR.

X. OTHER REMEDIES

If there are remedies applied at the site and not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is designed to accomplish (e.g., to contain contaminant plume, minimize infiltration and gas emissions).

The Site's 1988 FS Report stated that remedial alternatives were developed to eliminate or reduce the primary source of contamination to minimize the spread of contaminants to groundwater and surface water. The removal and treatment of contaminated source materials effectively reduces the migration of site-related contaminants to groundwater and surface water pathways. Operation of the GRUB area GWRS helps address residual source area contamination that was not removed during the OU2 remedial action. However, based on groundwater monitoring data, additional remedial actions may be needed to adequately address remaining groundwater contamination. Groundwater institutional controls, in the form of water supply agreements, are currently in place for residential properties downgradient from the facility property. Institutional controls have not been finalized for the site property to prevent future groundwater use, to prevent exposure to residual source area soil contamination or to prevent activities that could compromise the integrity of the selected remedy in the future

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

Site O&M consists of semi-annual groundwater and surface water monitoring; routine well inspections; maintenance of monitoring wells, extraction wells and access controls; and maintenance and operation of the WWTP. These activities are adequate to support the site remedy.

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. Based on groundwater monitoring data, additional remedial actions may be needed to adequately address remaining groundwater contamination. No other issues or observations suggest that the protectiveness of the remedy may be compromised in the future.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. No new opportunities for O&M optimization have been identified.

Appendix E: Photographs from Site Inspection

Main site entrance

Security gates restrict vehicular access to the Site

View of the Celanese facility from the parking lot

Extraction well PEW-3, located east of the main facility building

View of the back of the Celanese facility, looking north – extraction well PEW-3 is pictured to the left

Monitoring wells TD-3 and TD-4, located immediately east of the DuraFiber facility

View of the former GRUB area, looking northeast

Extraction wells IT-10, IT-11 and IT-12 – WWTP ponds are pictured in the background

View of the WWTP, looking south from the former GRUB area

WWTP headworks

WWTP aeration basin, looking south

View of the WWTP, looking east

Remnants of the warehouse previously used to stage and store materials during incineration activities

Former location of the on-site incinerator

Looking east toward Stream B where remedial actions took place, and toward surface water sampling location SW-5

Stormwater discharge structure, located immediately upstream from Stream B

Appendix F: Detailed ARARs Review

The ROD only identified the five indicator chemical listed below in Table F-1. However, the RI identified 17 additional contaminants that exceeded North Carolina 2L groundwater standards, making them groundwater COCs. An additional eight contaminants have since been detected above current North Carolina groundwater standards, making them groundwater COCs as well.

This FYR compared groundwater ARARs from the 1988 OU1 ROD to current ARARs (Table F-1). Of the indicator parameters, current ARARs for benzene and TCE are now less stringent. ARARs for chromium and lead are more stringent. No standard existed for bis(2-ethylhexyl)phthalate when the ROD was signed but a standard has since been added. Of the non-indicator parameters identified during the OU1 RI, standards for nickel and barium are now more stringent. Standards for trans-1,2-dichloroethylene, vinyl chloride, chlorobenzene, phenol, chlordane and selenium are less stringent. No standards existed for 1,1-dichloroethane, methylene chloride or chloroform at the time of the ROD, but standards have since been added. Previous and current standards for identified COCs are presented in Table F-1.

Table F-1: Previous and 2016 ARARs for Groundwater COCs

Contaminant	1988 NC Groundwater Standard (mg/L)[a]	2016 NC Groundwater Standard (mg/L)[b]	ARARs Change
Indicator Chemicals			
Benzene	0.0007	0.001	less stringent
Bis(2-ethylhexyl) phthalate	Not listed	0.003	new value
TCE	0.0028	0.003	less stringent
Chromium	0.05	0.01	more stringent
Lead	0.05	0.015	more stringent
Contaminants Detected above NC Groundwater Standards during RI that Were Not Identified as Indicator Chemicals			
Carbon tetrachloride	0.0003	0.0003	no change
Chlordane	0.000027	0.0001	less stringent
Chlorobenzene	0.00041	0.05	less stringent
Chloroform	Not listed	0.07	NA
Chloromethane	Not listed	0.003	NA
1,1-Dichoroethane	Not listed	0.006	NA
1,1-Dichloroethylene	0.007	0.007	no change
Methylene chloride	Not listed	0.005	NA
Phenol	0.001	0.03	less stringent
PCE	0.0007	0.0007	no change
Trans-1,2-dichloroethylene	0.07	0.1	less stringent
Vinyl chloride	0.000015	0.00003	less stringent
Barium	1	0.7	more stringent
Iron	0.3	0.3	no change
Manganese	0.05	0.05	no change
Nickel	0.15	0.1	more stringent
Selenium	0.01	0.02	less stringent
Contaminants Detected Above NC Groundwater Standards after ROD Signature			
Acetone	NA	6	NA
1,1-Biphenyl[c]	NA	0.4	NA

Contaminant	1988 NC Groundwater Standard (mg/L)[a]	2016 NC Groundwater Standard (mg/L)[b]	ARARs Change
Cis-1,2-dichloroethylene	NA	0.07	NA
1,4-Dioxane	NA	0.003	NA
Ethylene glycol	NA	10	NA
2-Methynaphthalene	NA	0.03	NA
Naphthalene	NA	0.006	NA
Arsenic	NA	0.01	NA

Notes:

a. Proposed standards obtained from a draft of a document by the State of North Carolina identified in the 1988 Final FS Report, completed for OU1.

b. Based on North Carolina groundwater standards: http://portal.ncdenr.org/c/document_library/get_file?uuid=36ead518-1fcf-4aa0-bbf6-df58a90f5b0f&groupId=38364. Accessed 3/11/2016.

c. 1,1-Biphenyl = 1,1-diphenyl. DOWTHERM™A consists of 1,1-biphenyl and diphenyl ether.

mg/L = milligram per liter

NA = not applicable; chemical not originally identified as a COC in the ROD so a cleanup goal not established at that time for comparison purposes

Appendix G: Institutional Controls

Table G-1: Deed Documents from Cleveland County Public Records Office

Water Supply Agreements[a]			
Date	**Book**	**Page Number**	**Impacted Parcel**[b]
July 1995	1170	1005	71061
July 1995	1168	1088	71045
July 1995	1166	2150	71058
July 1995	1166	2154	73375
July 1995	1166	2158	71052
July 1995	1166	2162	70848, 70849,70850, 5377
July 1995	1166	2166	5372
July 1995	1166	2174	71051
July 1995	1166	2186	73376
July 1995	1166	2190	40956
July 1995	1166	2194	71055
August 1995	1170	994	71060, 71061, 71048, 71053
August 1995	1170	996	71060
August 1995	1170	984	72859, 58117
August 1995	1170	982	72859, 58117
August 1995	1170	1011	71053
August 1995	1168	1104	5331, 5330, 5329
August 1995	1168	1098	5332, 60255
August 1995	1168	1093	5365, 44856
August 1995	1168	1084	58298, 71056, 71057
August 1995	1168	1080	5333, 57013, 53276
August 1995	1166	2146	5380, 5381
August 1995	1166	2170	71049
August 1995	1166	2178	71046
August 1995	1166	2182	71059
August 1995	1168	1076	71050
September 1995	1170	989	71047
September 1995	1170	987	71047
September 1995	1170	1016	71054
September 1995	1170	1000	71048
September 1995	1168	1070	71056
September 1995	1168	1073	71045
Consent Decree[a]***:*** Celanese agreed to conduct the remedial action to address OU2 contamination.			
November 1989	1235	2145	4512

Notes:

a. Water supply agreements and Consent Decree accessed via the Cleveland County Register of Deeds website, accessed 03/09/2016: http://northcarolina.countygovernmentrecords.com/NorthCarolinaRecorder/web.

b. Parcels identified using the Cleveland County GIS website, accessed 03/09/2016: http://arcgis.webgis.net/nc/Cleveland.

Figure G-1: Example Water Access Agreement

RECORDING FEE $ 14.00

BOOK 1166 PAGE 2146
CLEV. CO., NC
FILED

95 SEP -8 PM 2:52

BONNIE E. REECE
REGISTER OF DEEDS

Hoechst Celanese

Textile Fibers
Hoechst Celanese Corporation
PO Box 67
Shelby, NC 28151-0067
704 482 2411

August 10, 1995

Mr. and Mrs. Charles C. Allen
723 Lavender Rd.
Grover, NC 28073

Re: Water Supply Agreement: Property owned by Charles C. Allen and wife Barbara C. Allen, being tracts Numbers 9 and 10 inclusive, Phase I, Wildwood Meadows Subdivision, Recorded Plat Book 16, Page 88, Deed Book 1106, Page 495, all of the Cleveland County Registry (See Attachment "A")

Dear Mr. and Mrs. Allen,

As you know, we regularly monitor ground water near our plant site and have worked closely with you in the past in regard to your water quality concerns. From previous meetings, you also know of our proposal to make mutually satisfactory arrangements to provide you with assurances that there will be no future disruption of your water supply due to ground water quality concerns.

We believe the best way to accomplish this goal is for our company to pay all costs and fees necessary to connect the residence located on your property described above to the county water system. We will also reimburse you $4645.13, which we have mutually agreed represents the value of your existing well system. Additionally, to assure that your participation will have no short-term adverse effect on your family budget, we will reimburse you in advance $2269.49, which we have mutually agreed will compensate you fairly for five years county water service costs.

Your signatures below acknowledge receipt of a duplicate original of this letter and your agreement to the following:

(1) Your cooperation in our arrangements to connect your residence to the county water system.

(2) Your acknowledgment of your ownership of this property and except for any mortgage holder, no other person holds any interest in the property which would limit your authority in this agreement.

(3) Your agreement that when your residence is connected to county water, we are authorized to permanently seal existing wells on this property.

(4) Your agreement to a property restriction which prohibits the drilling of any new wells, or the reopening of any existing wells on the property, so long as a source of public water supply is available.

Hoechst

This agreement is binding on our company, its successors, and assigns and on you, your heirs, successors, and assigns. With your signatures, we will immediately proceed to secure your county water connection and well closures and immediately following the completion of your county water connection and well closures we will deliver our reimbursement check to you.

Thank you for your cooperation with this matter.

Sincerely yours,
Hoechst Celanese Corporation

By: _____
Clarence C. Kegley, Site Manager

Receipt acknowledged and terms agreed to:

Charles C. Allen (Seal) 8-10-95
Charles C. Allen Date

Barbara C. Allen (Seal) 8-1095
Barbara C. Allen Date

Witnessed by:

_____ (Seal) 8/10/95
Leslie D. Conner Date
Environmental Manager
Hoechst Celanese Corporation

Appendix H: Limited Vapor Intrusion Assessment for the TD Well Area and Well F-55

To determine if current concentrations of VOCs detected in site groundwater remain protective of the vapor intrusion exposure pathway, this FYR evaluated maximum concentrations of VOCs identified from shallow wells located near operational buildings. Well TD-3 is the closest shallow well adjacent to the production area building. TD-4 is also near this building. However, this well monitors the deeper groundwater zone. Well TD-3 best represents the vapor source closest to the building foundation. This limited vapor intrusion assessment involved entering 2015 VOC concentrations detected in TD-3 into EPA's 2015 VISL calculator to estimate cancer risk and non-cancer HI using the default assumptions for commercial land use and the default groundwater temperature of 25 degrees Celsius. The calculator demonstrates that the cumulative risks associated with chloroform and TCE detected in well TD-3 are within EPA's risk management range of 1×10^{-6} to 1×10^{-4} as well as below the non-cancer HI of 1.0 (Table H-1).

Table H-1: Screening Level Vapor Intrusion Risk Evaluation Using Shallow Well TD-3

COC	2015 Concentration in TD-3 (µg/L)	2015 VISL Calculator[a] Commercial/Industrial Exposure Average Groundwater Temperature: 25°C	
		Cancer Risk	Non-cancer Hazard Index
Chloroform	1.4	3.9×10^{-7}	0.00049
TCE	16.5	2.2×10^{-6}	0.76
Totals		2.6×10^{-6}	0.76

Notes:
a. Concentrations from Table 3-5 of OU1 Semiannual Report First Half of 2015. Prepared by AECOM September 2015.
b. November 2015 VISL calculator, accessed at: http://www.epa.gov/oswer/vaporintrusion/guidance.html.

According to the EPA's 2015 guidance, one line of evidence that would trigger the need for a vapor intrusion evaluation is if a building is located within a distance of 100 feet vertically or horizontally from a vapor source. Deep well F-55 contains DNAPL and elevated concentrations of VOCs and SVOCs. However, this well is located about 250 feet downgradient of the production area building. Therefore, this location is not expected to contribute to the vapor intrusion exposure pathway at the production area building.

Appendix I: Detailed Data Review

Groundwater

This FYR evaluated groundwater data collected during semi-annual monitoring events from March 2011 to March 2015, examining indicator chemicals and the other constituents detected above the current North Carolina groundwater standards. PRP contractor AECOM performs monitoring to evaluate the performance of MNA and of the GRUB area GWRS (Figure 4). Table I-1 lists the wells used to monitor the performance of those two groundwater remedy components.

Table I-1: Summary of Wells Used to Monitor the Groundwater Remedy

GRUB Area Wells	Sitewide MNA Wells
IT-10, IT-11, IT-12, CC-64, IT-5, IT-6, IT-7, IT-8R, IT-9, K-28, K-58, V-23 and V-65	AA-54, C-49, CC-33, CC-64, DD-58R, F-55, G-50, G-88, GG-61, HH-48, HH-77, I-57, II-112, II-65, IT-10, IT-11, IT-12, IT-5, IT-6, IT-7, IT-8R, IT-9, K-28, K-58, KK-55, OT-2R, PEW-1, PEW-3, PEW-4, QQ-110, RR-131, T-35, TD-2, TD-3, TD-4, TI-2, TI-23 and V-65

AECOM performs groundwater monitoring at the Site per the 2010 Work Plan and Field Sampling Plan for Supplemental Investigation and Long-Term Groundwater Monitoring. Monitoring activities include analysis of VOCs, SVOCs, 1,4-dioxane and EG for MNA monitoring wells and analysis of 1,4-dioxane, EG and COD for wells associated with the GRUB Area GWRS. Of the five indicator chemicals established in the ROD (benzene, bis(2-ethylhexyl)phthalate, chromium, lead and TCE), only benzene, TCE and bis(2-ethylhexyl)phthalate concentrations are routinely monitored. Metals have not been analyzed since March 2011. Based on the results of expanded sampling in 2010 and 2011, Celanese requested that metals be removed from the sitewide sampling program in a September 2011 document titled "Proposed Long-term Monitoring Plan Technical Memorandum, Celanese Fibers Operations Site, Shelby, North Carolina". In 1995, the EPA approved a request to stop monitoring for metals at select site locations. EPA approval for the 2011 request has not been documented. AECOM compares groundwater monitoring data to current North Carolina 2L groundwater standards.

In general, monitoring data collected between March 2011 and March 2015 indicate that concentrations of several groundwater COCs routinely exceed their respective North Carolina 2L groundwater standards and MCLs. Overall, groundwater COC concentrations tend to fluctuate sitewide, with no significant decreasing trends observed over time. These findings suggest that MNA and the operation of the GRUB area GWRS may not be capable of adequately addressing residual sources of groundwater contamination at the Site. With the possible exception of 1,4-dioxane, groundwater monitoring data suggest that groundwater COCs are not migrating off site. Monitoring data results are discussed below for the indicator chemicals identified in the ROD (that are still monitored) and for other prevalent groundwater COCs that routinely exceed cleanup goals.

Bis(2-ethylhexyl)phthalate (original ROD indicator chemical)

With the exception of an estimated result of 0.00471 mg/L in March 2013 at well F-55, bis(2-ethylhexyl)phthalate was not detected in any groundwater samples between March 2011 and March 2015. However, the laboratory detection limits routinely used to analyze bis(2-ethylhexyl)phthalate are higher than the cleanup goal of 0.003 milligrams per liter (mg/L). For example, the March 2015 sampling event used a detection limit of 0.006 mg/L. In September 2013, the laboratory detection limits for the constituent were 2 mg/L and 0.0100 mg/L, both of which are higher than the cleanup goal of 0.003 mg/L. The detection limits used must be equal to or lower than the cleanup goal in order accurately compare groundwater monitoring results to cleanup goals.

Benzene (original ROD indicator chemical)

Between March 2011 and March 2015, benzene concentrations exceeded the North Carolina 2L groundwater standard of 0.001 mg/L at least once in 16 wells (Table I-2). During that same period, benzene concentrations exceeded the MCL of 0.005 mg/L at least once in 13 wells. Benzene at all other wells was either not detected or detected at concentrations below the cleanup goal. Wells IT-7 and F-55 routinely show the highest benzene concentrations (Table I-2). Well IT-7 is located immediately downgradient from the former GRUB area. Well F-55 is located east of the plant production area (Figure 4). In general, since March 2011, benzene concentrations tend to fluctuate sitewide, with no significant trends observed.

Table I-2: Benzene Exceedances of the Current North Carolina 2L Groundwater Standard, 2011-2015

Sampling Date	2016 NC 2L Standard (mg/L)	MCL (mg/L)	Benzene						
			Monitoring Well						
			CC-33	F-55	G-88	IT-10	IT-11	IT-12	IT-5
03/2011	0.001	0.005	0.00121	**0.0489***	**0.00156**	NA	NA	NA	**0.00534* J**
10/2011	0.001	0.005	**0.00180**	<0.1	NS	NA	NA	NA	<0.0100
03/2012	0.001	0.005	**0.00134**	**0.0456 J***	NS	NA	NA	NA	<0.010
09/2012	0.001	0.005	**0.00160 J**	<0.0500	**0.00295**	**0.00489**	**0.0203* J**	**0.00726* J**	**0.00333 J**
03/2013	0.001	0.005	**0.00131**	**0.0391**	**0.00183**	<0.0100	**0.0139***	**0.00649***	**0.00478**
09/2013	0.001	0.005	**0.00150**	**0.0374***	**0.00193**	**0.00159 J**	<0.00100	**0.00847***	**0.00220 J**
03/2014	0.001	0.005	0.00096 J	**0.0467***	**0.0025**	**0.0054***	**0.0116***	**0.0082***	**0.0062***
09/2014	0.001	0.005	<0.0010	**0.0391***	**0.0040**	**0.0061***	**0.0119***	**0.0071***	**0.0053 J***
03/2015	0.001	0.005	<0.0010	**0.0411***	**0.0053***	**0.0056***	**0.0103***	**0.0077***	**0.0057***

Notes:
All units are in mg/L.
Bold and **shaded** = exceedance of current North Carolina 2L Groundwater Standard
* = MCL exceedance
J = estimated concentration
NA = not applicable; wells IT-10, IT-11 and IT-12 were not installed until late 2012
NS = not sampled
Values highlighted in yellow = laboratory detection limit higher than the 0.001 mg/L cleanup goal

Table I-2 continued.

Sampling Date	2016 NC 2L Standard (mg/L)	MCL (mg/L)	Benzene								
			Monitoring Well								
			IT-6	IT-7	IT-8R	IT-9	K-28	PEW-1	TD-4	V-23	V-65
03/2011	0.001	0.005	**0.0166***	**0.0456***	**0.102***	**0.0137***	**0.00781* J**	**0.00136**	<0.050	**0.0126***	**0.00227**
10/2011	0.001	0.005	<0.010	**0.0261***	NS	NS	**0.00542* J**	**0.00124**	<0.050	<0.0010	**0.00221**
03/2012	0.001	0.005	<0.010	**0.0304***	NS	NS	<0.010	**0.00135**	<0.050	<0.020	**0.00259**
09/2012	0.001	0.005	<0.0400	**0.0261***	NS	NS	<0.0100	**0.00133**	<0.0500	<0.0200	**0.00276 J**
03/2013	0.001	0.005	**0.0129***	**0.0570***	NS	NS	**0.00659* J**	**0.00187**	**0.0125***	**0.00686***	**<0.0100**
09/2013	0.001	0.005	**0.0157***	**0.0479***	NS	NS	**0.00597* J**	**0.00148**	<0.0500	**0.00863* J**	**0.00358**
03/2014	0.001	0.005	**0.0155***	**0.0750***	NS	NS	**0.0051***	**0.0014**	**0.0172* J**	**0.0060***	**0.0023**
09/2014	0.001	0.005	**0.0145***	**0.0477***	NS	NS	**0.0061***	**0.0021**	<0.0500	NS	NS
03/2015	0.001	0.005	<0.1	**0.0716***	NS	NS	<0.0050	**0.0018**	<0.0500	**0.0040**	**0.0049**

Notes:
All units are in mg/L.
Bold and **shaded** = exceedance of current North Carolina 2L Groundwater Standard
* = MCL exceedance
J = estimated concentration
NA = not applicable; wells IT-10, IT-11 and IT-12 were not installed until late 2012
NS = not sampled
Values highlighted in yellow = laboratory detection limit higher than the 0.001 mg/L cleanup goal
If a duplicate sample was collected, the higher of the two results is included in the table above.

TCE (original ROD indicator chemical)
Between March 2011 and March 2015, TCE concentrations exceeded both the North Carolina 2L groundwater standards of 0.003 mg/L and the MCL of 0.005 mg/L at least once in 13 wells (Table I-3). TCE at all other wells was either not detected or detected at concentrations below the cleanup goal. In general, since March 2011, TCE concentrations tend to fluctuate sitewide, with no significant trends observed.

Monitoring well TD-4 routinely contains the second highest concentrations of TCE sitewide, ranging from a low of 5.02 mg/L in March 2012 to a high of 7.76 mg/L in September 2012. Well QQ-110, located immediately adjacent to well TD-4, consistently shows the highest TCE concentrations, ranging from a low of 40.7 mg/L in September 2012 to a high of 51.4 mg/L in September 2013. Monitoring well QQ-110 is a bedrock monitoring well installed as a deep cluster well near monitoring wells TD-3 and TD-4 to delineate the vertical extent of TCE at this location. Wells TD-4 and QQ-110 are located immediately east of the eastern wall of the plant production area (Figure 4). DuraFiber operates inside the building immediately adjacent to the wells (west). The presence of TCE at concentrations high above the MCL, in close proximity to an occupied building (less than 100 feet), triggered the need to evaluate the potential for vapor intrusion at the production area building. See Section 7.2 for additional vapor intrusion discussion.

Between March and May 2012, AECOM investigated the TD well area to delineate the vertical and lateral extent of TCE in groundwater and to investigate possible sources. The investigation found that TCE concentrations in groundwater in the vicinity of TD-3 and TD-4 increase with depth. TCE concentrations in the deep interval (85 to 90 feet below ground surface) are typically two orders of magnitude higher than concentrations found at TD-3 and TD-4. The investigation found a lack of TCE daughter/breakdown products in the groundwater samples, indicating that TCE in the area of TD-3 and TD-4 is not degrading. TCE concentrations at wells south and southeast of the TD well cluster are consistently below the North Carolina 2L groundwater standard (wells TD-2 and I-57), indicating that the TCE plume is not migrating in that direction. TCE concentrations at well PEW-1, located northeast of the TD well area, remain elevated above state and federal standards and show a slight increase over time. These data indicate the possibility of TCE plume migration from the TD well area, toward the northeast (Figure 4).

The lack of a noticeable decreasing trend in TCE concentrations over time, and the lack of detection of daughter/breakdown products, indicates that MNA and the operation of the GWRS may not be capable of adequately addressing the source of TCE in site groundwater.

Table I-3: TCE Exceedances of the Current North Carolina 2L Groundwater Standard, 2011-2015

Sampling Date	2016 NC 2L Standard (mg/L)	MCL (mg/L)	Trichloroethylene (TCE)												
			Monitoring Well												
			CC-33	CC-64	G-50	G-88	PEW-1	PEW-3	QQ-110	RR-131	TD-3	TD-4	TI-2	V-23	F-55
03/2011	0.003	0.005	**0.00610***	**0.0617***	<0.001 U	**0.0987***	**0.0171***	<0.001 U	NA	NA	**0.0594***	**5.89***	**0.00876***	<0.01 U	<0.01 U
10/2011	0.003	0.005	**0.00686***	NS	**0.00397**	NS	**0.0146***	0.000810 J	NA	NA	**0.0451***	**5.73***	**0.00703***	<0.00100	<0.1
03/2012	0.003	0.005	**0.00875***	NS	<0.001	NS	**0.0207***	0.000690 J	NA	NA	**0.0369***	**5.02***	**0.00617***	<0.020	<0.050
09/2012	0.003	0.005	**0.00734* J**	NS	0.00189	**0.112***	**0.0300***	0.00203	**40.7***	**0.0693***	**0.0366***	**7.76* J**	**0.00852* J**	<0.0200	<0.0500
03/2013	0.003	0.005	**0.00616***	NS	<0.00100	**0.0811***	**0.0238***	0.00191	**43.7***	**0.0474***	**0.0307***	**5.96***	**0.00695***	**0.0523* J**	**0.0329* J**
09/2013	0.003	0.005	**0.0112***	NS	0.00254	**0.0937***	**0.0308***	0.00103	**51.4***	**0.0960***	**0.0218***	**6.16***	**0.0114***	<0.0100	<0.0100
03/2014	0.003	0.005	**0.0087***	NS	**0.0050**	**0.108***	**0.0271***	0.0028	**45.3***	**0.145***	**0.0183***	**5.66***	**0.0081***	<0.0010	0.0018
09/2014	0.003	0.005	**0.0091***	NS	**0.0055***	**0.0935***	**0.0308***	**0.0133***	**45.8***	**0.193***	**0.0197***	**6.42***	**0.0065***	<0.0010	<0.0025
03/2015	0.003	0.005	**0.0083***	NS	**0.0070***	**0.12***	**0.0337***	0.0023	**40.9***	**0.0383***	**0.0165***	**7.36***	**0.0088***	<0.0010	<0.0025

Notes:
All units are in mg/L.
Bold and **shaded** = exceedance of current North Carolina 2L Groundwater Standard
* = MCL exceedance
J = estimated concentration
NA = not applicable; wells IT-10, IT-11 and IT-12 were not installed until late 2012 and wells QQ-110 and RR-131 were not installed until May 2012
NS = not sampled
Values highlighted in yellow = laboratory detection limit higher than the cleanup goal
Between March 2011 and March 2015, the following wells were sampled only once for TCE, in March 2011, and are not included in the table above: HH-48 (3/2011 TCE = 0.108 mg/L), HH-77 (3/2011 TCE = 0.362 mg/L), H-59 (3/2011 TCE = 0.00882 mg/L) and H-79 (3/2011 TCE = 0.0164 mg/L).
If a duplicate sample was collected, the higher of the two results is included in the table above.

1,4-Dioxane

1,4-Dioxane is a solvent used in manufacturing operations. It is highly soluble in water, does not readily bind to soils and readily leaches to groundwater. It is also resistant to naturally occurring biodegradation processes. Due to these properties, a 1,4-dioxane plume is often much larger (and further downgradient) than the associated solvent/VOC plume.

Between March 2011 and March 2015, 1,4-dioxane concentrations exceeded the North Carolina 2L groundwater standard of 0.003 mg/L at least once at almost all site wells (Table I-4). Data from March 2011 to March 2015 indicate there are two primary sources of 1,4-dioxane at the Site; the former GRUB disposal area and the area east of the plant production area. The highest concentrations are routinely observed at well IT-6, located immediately downgradient of the former GRUB area, and newly installed extraction wells (Figure 4). Between March 2011 and March 2015, 1,4-dioxane concentrations at IT-6 ranged from a low of 2.19 in March 2014 to a high of 4.15 mg/L in September 2014. Wells IT-5, IT-11 and IT-12 – also located at or immediately adjacent to the former GRUB area – show the next highest concentrations of 1,4-dioxane (Table I-4). These elevated concentrations are expected, as the wells are located at the former GRUB area, which is the primary source area for 1,4-dioxane at the Site. Well I-57, located southeast of the plant production area, also routinely shows elevated 1,4-dioxane concentrations (Figure 4).

Groundwater data collected during this FYR period detected 1,4-dioxane concentrations at most depths throughout the saprolite and shallow bedrock zones. Previous expanded sampling events reported that downgradient from the source areas, the higher concentrations tend to occur in the deep saprolite and the shallow bedrock, with generally lower concentrations in the deep bedrock.

The March 2015 detections of 1,4-dioxane in samples from monitoring wells KK-55 (0.153 mg/L) and DD-58R (0.0608 mg/L) show that the impacted groundwater has migrated across the small tributaries at some locations. Even though the surface streams capture the shallow groundwater, there is some underflow in the deeper and less well-connected portions of the fracture system. Groundwater monitoring data indicate that the extent of 1,4-dioxane contamination in groundwater has not been fully defined.

Table I-4: 1,4-Dioxane Exceedances of the Current North Carolina 2L Groundwater Standard, 2011-2015

Monitoring Well	2016 NC 2L Standard (mg/L)	1,4-Dioxane								
		Sampling Date								
		03/2011**	10/2011	03/2012	09/2012	03/2013	09/2013	03/2014	09/2014	03/2015
AA-54	0.003	**0.2**	**0.204**	**0.247**	**0.253**	**0.235**	**0.226**	**0.191**	**0.176**	**0.153**
C-49	0.003	<0.00200	<0.00200	<0.002	<0.00200	<0.00200	<0.00200	<0.00200	**0.0031**	<0.0020
CC-33	0.003	**0.0734**	**0.0772**	**0.0748**	**0.0796**	**0.0690**	**0.0710**	**0.584**	**0.0625**	**0.0677 J**
CC-64	0.003	**0.337**	NS	NS	**0.191**	**0.232**	**0.213**	**0.195**	**0.207**	**0.255**
DD-58R	0.003	**0.0981**	**0.0951**	**0.0832**	**0.0743**	**0.101**	**0.0697**	**0.0679**	**0.0943**	**0.0608**
G-50	0.003	**0.464**	**0.292**	**0.201**	**0.112**	**0.0835**	**0.0401**	**0.0399**	**0.0224**	**0.0142**
G-88	0.003	**0.0118**	NS	NS	**0.0123**	**0.0132**	**0.0105**	**0.0125**	**0.0170**	<0.0020
GG-61	0.003	**0.0731**	**0.0529**	**0.0587**	**0.0555**	**0.0521**	**0.0392**	**0.0640**	**0.0425**	**0.0413**
HH-48	0.003	0.00247	<0.00200	0.00260 J	0.00162 J	0.00297	0.00154 J	<0.0020	**0.0060**	<0.0024 U
HH-77	0.003	**0.00316**	<0.00200	<0.002 U	0.00227	**0.00316**	<0.0020	<0.00200	**0.0045**	<0.0020
I-57	0.003	**0.614**	**0.824**	**1.01**	**1.11**	**0.634**	**1.6**	**1.72**	**1.08**	**0.0379**
II-112	0.003	**0.0337**	NS	NS	**0.0334**	**0.0331**	**0.0196**	**0.0332**	**0.0403**	**0.0520**
II-65	0.003	**0.299**	**0.275**	**0.301**	**0.274**	**0.296**	**0.233**	**0.22**	**0.137**	**0.137**
IT-4	0.003	**0.0469**	NS	NS	NS	**1.14**	NS	NS	NS	NS
IT-10	0.003	NA	NA	NA	**0.786**	**0.671**	**0.6**	**0.562**	**0.624**	**0.535**
IT-11	0.003	NA	NA	NA	**2.890**	**1.840**	**1.26**	**1.02**	**0.61**	**1.28**
IT-12	0.003	NA	NA	NA	**1.060**	**1.400**	**1.21**	**1.11**	**1.14**	**1.28**
IT-5	0.003	**1.82**	**2.19**	**1.85**	**1.750**	**1.130**	**1.51**	**1.0**	**2.36**	**0.713**
IT-6	0.003	**3.13**	**2.83**	**2.95**	**2.820**	**3.110**	**2.3**	**2.19**	**4.15**	**2.93**
IT-7	0.003	**0.573**	**0.556**	**0.561**	**0.495**	**0.550**	**0.441**	**0.403**	**0.547**	**0.545**
IT-8R	0.003	**1.56**	NS	NS	**1.290***	**1.010**	**0.8**	**0.0994**	**0.789**	**1.32**
IT-9	0.003	**0.473**	NS	NS	**0.386**	**0.448**	**0.296**	**0.359**	**0.351**	**0.425**
K-28	0.003	**0.539**	**1.06**	**0.95**	**1.140**	**1.030**	**1.07**	**0.965**	**1.21**	**0.987**
K-58	0.003	**0.494**	NS	NS	**0.486***	**0.561**	**0.523**	**0.678**	**0.715**	**0.614**
KK-55	0.003	**0.145**	**0.135**	**0.174**	**0.145**	**0.161**	**0.124**	**0.195 J**	**0.144**	**0.153**
OT-2R	0.003	**0.115**	**0.101**	**0.11**	**0.0997**	**0.0995**	**0.0686**	**0.0769**	**0.0722**	**0.0960**
RR-131	0.003	NA	NA	NA	0.00260	0.00157 J	0.00250	**0.0104**	**0.0168**	<0.0020

Monitoring Well	2016 NC 2L Standard (mg/L)	1,4-Dioxane								
		Sampling Date								
		03/2011	10/2011	03/2012	09/2012	03/2013	09/2013	03/2014	09/2014	03/2015
T-35	0.003	**0.0762**	**0.0790**	**0.0949**	**0.117**	**0.15**	**0.142**	**0.164**	**0.132**	**0.175 J**
TD-2	0.003	0.00267	**0.00900**	**0.00423 J**	**0.00309**	0.00233	<0.00200	<0.00200	**0.0046**	**0.0039 J**
TD-3	0.003	0.00114 J	**0.00226 J**	<0.00200 U	<0.00200	0.00116 J	<0.00200	<0.00200	**0.0121**	<0.0020
TI-2	0.003	**0.00589**	**0.00428 J**	**0.00745 J**	**0.00585**	**0.00519**	**0.00434**	0.0024	**0.0077**	**0.0062 J**
V-23	0.003	**1.76**	**2.29**	**2.18**	**2.13**	**0.556**	**0.649**	**0.276**	**0.614**	**0.193**
V-65	0.003	**0.455**	**0.481**	**0.652**	**0.535**	**1.04**	**0.62**	**0.0778**	NS	**0.9**
F-55	0.003	**0.283**	**0.245**	**0.367**	**0.254**	**0.368**	**0.33**	**0.35**	**0.276 J**	**0.342**
PEW-1	0.003	**0.0318**	**0.0340**	**0.0412**	**0.0484**	**0.0346**	**0.301**	**0.0472**	**0.0355**	**0.0323**
PEW-3	0.003	<0.002 U	<0.00200 U	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	**0.0049 J**
PEW-4	0.003	**0.0992**	**0.0961**	NS	**0.0741**	**0.103**	**0.0720**	**0.0922**	**0.193**	**0.0671**
QQ-110	0.003	NA	NA	NA	**0.00431**	**0.00512**	**0.00451**	<0.4	<0.0050	**0.0035 J**

Notes:
All units are in mg/L.
Bold and **shaded** = exceedance of current North Carolina 2L Groundwater Standard
J = estimated concentration
U = analyte not detected
NA = not applicable; wells IT-10, IT-11 and IT-12 were not installed until late 2012 and wells RR-131 and QQ-110 were not installed until May 2012
NS = not sampled
Values highlighted in yellow = laboratory detection limit higher than the cleanup goal
* = Sample collected on 10/10/2012
** = Not all wells that showed exceedances of the North Carolina 2L groundwater standard for 1,4-dioxane in March 2011 are included in this table. Several wells that showed exceedances of the 1,4-dioxane standard in March 2011 either did not show exceedances during any other sampling events since then, or have not been sampled since March 2011.
If a duplicate sample was collected, the higher of the two results is included in the table above.

Ethylene Glycol

Historical and current groundwater monitoring data indicate the presence of two distinct areas impacted by EG – the area surrounding well F-55, east of the polymer production area, and immediately downgradient of the former GRUB waste disposal area. Between March 2011 and March 2015, EG concentrations exceeded the North Carolina 2L groundwater standard of 10 mg/L at least once at 13 wells (Table I-5). EG at the rest of the wells was either not detected or detected at concentrations below the North Carolina 2L groundwater standard. During that same period, well IT-11 – located at the former GRUB area – showed the highest EG concentrations, ranging from a low of 1,160 mg/L in March 2013 to a high of 3,890 mg/L in March 2015. EG concentrations at well F-55 ranged from a low of 586 mg/L in October 2011 to a high of 2,610 mg/L in March 2011. In general, since March 2011, EG concentrations tend to fluctuate sitewide, with recent (March 2015) decreasing concentrations observed at wells immediately downgradient of the extraction wells (IT-5, IT-7, IT-8R, IT-10, IT-12, K-28, V-23 and V-65) (Table I-5). These decreases suggest that the extraction system is effectively removing EG from site groundwater at the former GRUB area.

In March 2015, well K-55 – located northeast of the former GRUB area and north of Stream B – showed an EG concentration of 61.6 mg/L. During this review period, prior to the March 2015 sampling event, EG was not detected at that location. Based on historical results for well K-55, continued monitoring of this well is recommended to determine if the March 2015 result was an isolated event or whether contaminant migration is occurring.

EG is readily biodegradable under aerobic and anaerobic conditions. Depletion of oxygen and a reducing environment are expected when native microorganisms biodegrade EG. Low dissolved oxygen concentrations in the vicinity of well F-55 and the K and V wells support the conclusion that both aerobic and anaerobic biodegradation of EG is occurring.

SVOCs at Well F-55

Between March 2011 and March 2015, concentrations of 1,1-biphenyl, naphthalene and phenol exceeded their respective North Carolina 2L standards only at well F-55. Well F-55 is located east of the production area. DOWTHERM^{TM}A is a heat transfer fluid comprised of about 73 percent diphenyl ether and 27 percent 1,1-biphenyl. This DNAPL is routinely found in well F-55, as the use of the fluid in previous facility operations impacted the well. Diphenyl ether does not have a North Carolina 2L standard or MCL. The North Carolina 2L groundwater standard for 1,1-biphenyl is 0.4 mg/L. Between March 2011 and March 2015, concentrations of 1,1-biphenyl consistently exceeded the North Carolina 2L groundwater standard, ranging from a low of 2.62 mg/L in September 2012, to a high of 25.4 mg/L in March 2014. Naphthalene and phenol routinely exceed their respective North Carolina 2L groundwater standards (Table I-6). In general, since March 2011, 1,1-biphenyl, naphthalene and phenol concentrations tend to fluctuate at F-55, with no significant trends observed.

When detected during sampling events, AECOM measures the depth of the DNAPL in well F-55 and recovers it using a disposable polyethylene bailer. Between June 2006 and March 2011, the thicknesses of DNAPL observed in well F-55 remained relatively stable. Since October 2011, the DNAPL thicknesses measured in well F-55 have shown an overall increase (Table I-7). This increase suggests that MNA and the operation of the GWRS may not be capable of addressing the source of DNAPL at well F-55. It also may indicate an ongoing source of DOWTHERM^{TM}A at or near well F-55.

Table I-5: Ethylene Glycol Exceedances of the Current North Carolina 2L Groundwater Standard, 2011-2015

Sampling Date	2016 NC 2L Standard (mg/L)	Ethylene Glycol												
		Monitoring Well												
		F-55	IT-5	IT-6	IT-7	IT-8R	IT-9	IT-10	IT-11	IT-12	K-28	KK-55	V-23	V-65
03/2011	10	**2,610**	**235**	**997**	<7.00 U	**689**	<7.00 U	NA	NA	NA	**1,200**	<7.00 U	**1,200**	<7.00 U
10/2011	10	**586**	**102**	**274**	<7.0	NS	NS	NA	NA	NA	**654**	<7.0	**901**	<7.0
03/2012	10	**1,530**	**588**	**1,080**	<7.0	NS	NS	NA	NA	NA	**85.7**	<7.0	**1,280**	<7.0
09/2012	10	**893**	**45.4**	**387**	<7.0	<7.0*	<7.0*	<7.0	**1,230**	<7.0	**71.7**	<7.0	**746**	<7.0
03/2013	10	**760**	**108 J**	**443**	**64.6**	**240**	**43.3**	**347**	**1,160**	**738**	**85.7**	<7.0	**13.9**	<7.0
09/2013	10	**1,910 J**	**474**	**670**	<7.0	**593**	<14	**18.6**	**2,290**	**1,590**	**355**	<7.0	**161**	<7.0
03/2014	10	**2,150**	**1,080**	**1,000**	**99.4**	**22.7**	<10	**343**	**2,170**	**1,440**	**79.6**	<10.0	**59.1**	**20.2**
09/2014	10	**1,090**	**82.3**	**68.4 J**	**75.7**	<100	<10	**97.1**	**1,460**	**410**	<100	<10.0	NS	NS
03/2015	10	**1,500**	<5.0	**103**	<5.0	<5.0	<5.0	**73.9**	**3,890**	**376 J**	<5.0	**61.6**	<5.0	<5.0

Notes:
All units are in mg/L.
Bold and shaded = exceedance of current North Carolina 2L Groundwater Standard
J = estimated concentration
U = analyte not detected
NA = not applicable; wells IT-10, IT-11 and IT-12 were not installed until late 2012
NS = not sampled
Values highlighted in yellow = laboratory detection limit higher than the 10 mg/L cleanup goal
* = Sample collected on 10/10/2012
If a duplicate sample was collected, the higher of the two results is included in the table above.

Table I-6: SVOC Exceedances of the Current North Carolina 2L Groundwater Standards, 2011-2015

SVOCs at Well F-55						
Sampling Date	**1,1-Biphenyl 2016 NC 2L Standard (mg/L)**	**Results (mg/L)**	**Naphthalene 2016 NC 2L Standard (mg/L)**	**Results (mg/L)**	**Phenol 2016 NC 2L Standard (mg/L)**	**Results (mg/L)**
03/2011	0.4	**11.0**	0.006	<5	0.03	<5
10/2011	0.4	**6.02**	0.006	**0.0219 J**	0.03	**0.3**
03/2012	0.4	**9.44**	0.006	<1 J	0.03	**0.164 J**
09/2012	0.4	**2.62**	0.006	<1	0.03	**0.263 J**
03/2013	0.4	**8.37 J**	0.006	**0.0943**	0.03	**0.384 J**
09/2013	0.4	**3.77**	0.006	<2	0.03	**0.321 J**
03/2014	0.4	**25.4**	0.006	**0.0626 J**	0.03	**0.462 J**
09/2014	0.4	**4.2**	0.006	**0.0183**	0.03	**0.377**
03/2015	0.4	**4.15**	0.006	**0.0203**	0.03	**0.245 J**

Notes:
All units are in mg/L.
Bold and **shaded** = exceedance of current North Carolina 2L Groundwater Standard
J = estimated concentration
Values highlighted in yellow = laboratory detection limit higher than the cleanup goal
If a duplicate sample was collected, the higher of the two results is included in the table above.

Table I-7: DNAPL Thicknesses Measured at Well F-55, 2006-2015

Sampling Date	DNAPL Thickness (feet)	Sampling Date	DNAPL Thickness (feet)
06/06/2006	0.85	10/16/2008	0.2
08/15/2006	1.3	03/20/2009	1.7
09/11/2006	0	11/05/2009	0.2
11/06/2006	0	03/17/2010	0.2
01/22/2007	0	09/24/2010	ND
01/24/2007	Not measured	03/17/2011	ND
04/16/2007	0	10/12/2011	2.24
04/20/2007	1.25	03/20/2012	2.69
07/19/2007	0.5	09/20/2012	2.23
11/01/2007	0.5	03/13/2013	2.14
01/24/2007	1.2-1.8	09/25/2013	2.92
01/30/2007	0.7-1.2	03/20/2014	0.2
04/17/2008	0.2	09/23/2014	2.6
07/24/2008	0.2	03/09/2015	2.85

Notes:
ND = not detected

Surface Water

AECOM performs semi-annual monitoring of surface water at two site locations, SW-4 and SW-7 (Figure 4). Results are compared to North Carolina Administrative Code, Title 15A, Subchapter 2B (NCAC 2B) surface water standards. Between March 2011 and March 2015, 1,4-dioxane was the only constituent detected in site surface water. During that same period, none of the results exceeded the NCAC 2B standard of 0.08 mg/L (Table I-8). However, detectable concentrations of 1,4-dioxane in surface water indicate that the constituent is being discharged from groundwater into site streams. While 1,4-dioxane is recalcitrant in the subsurface, degradation is more rapid once discharged to surface water and exposed to volatilization and sunlight. The surface water concentrations will continue to decrease as the surface water flows downstream due to degradation and influx of non-impacted groundwater downgradient of the Site.

Table I-8: Surface Water Detections of 1,4-Dioxane, 2011-2015

Surface Water Detections of 1,4-Dioxane			
Sampling Date	**1,4-Dioxane 2016 NC 2B Standard (mg/L)**	**SW-4**	**SW-7**
03/2011	0.08	0.00966	0.00340
10/2011	0.08	0.0337 J	0.0181
03/2012	0.08	0.0266	0.0163
09/2012	0.08	0.0113	0.00698
03/2013	0.08	0.0122	0.00553
09/2013	0.08	0.0104	0.00697
03/2014	0.08	0.0159	0.0053
09/2014	0.08	0.0424	0.0209
03/2015	0.08	0.0284	0.0145
Notes: J = estimated concentration If a duplicate sample was collected, the higher of the two results is included in the table above.			

Soil

In March 2012, as part of the TD well area investigation, AECOM collected soil samples from six areas, at various depths, from the area surrounding the TD wells. Samples were analyzed for VOCs. All VOC concentrations were below detection limits. These results indicate the lack of a definable source of TCE near wells TD-3 and TD-4.

May 2011 Limited Vapor Intrusion Evaluation

Prior to the previous FYR, MNA sampling identified elevated concentrations of TCE at monitoring wells HH-48 and HH-77, located in the downgradient residential area, about 1,700 feet east of the Celanese facility fence line. Expanded sampling efforts in September 2010 and March 2011 found no connection between TCE concentrations in site groundwater and TCE in wells HH-48 and HH-77. Based on those results, wells HH-48 and HH-77 were not sampled for VOCs during this FYR period. A limited vapor intrusion assessment by the EPA in May 2011

concluded that vapor intrusion does not pose an unacceptable risk to human health for the residence near wells HH-48 and HH-77. The assessment determined that no further vapor intrusion evaluation was needed for the area.